NATIONAL EDITION

JULY
1947

CHEMICAL ENGINEERING

WITH CHEMICAL & METALLURGICAL ENGINEERING

Chem & Met

issue features: flexible
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chemical industry, neu-
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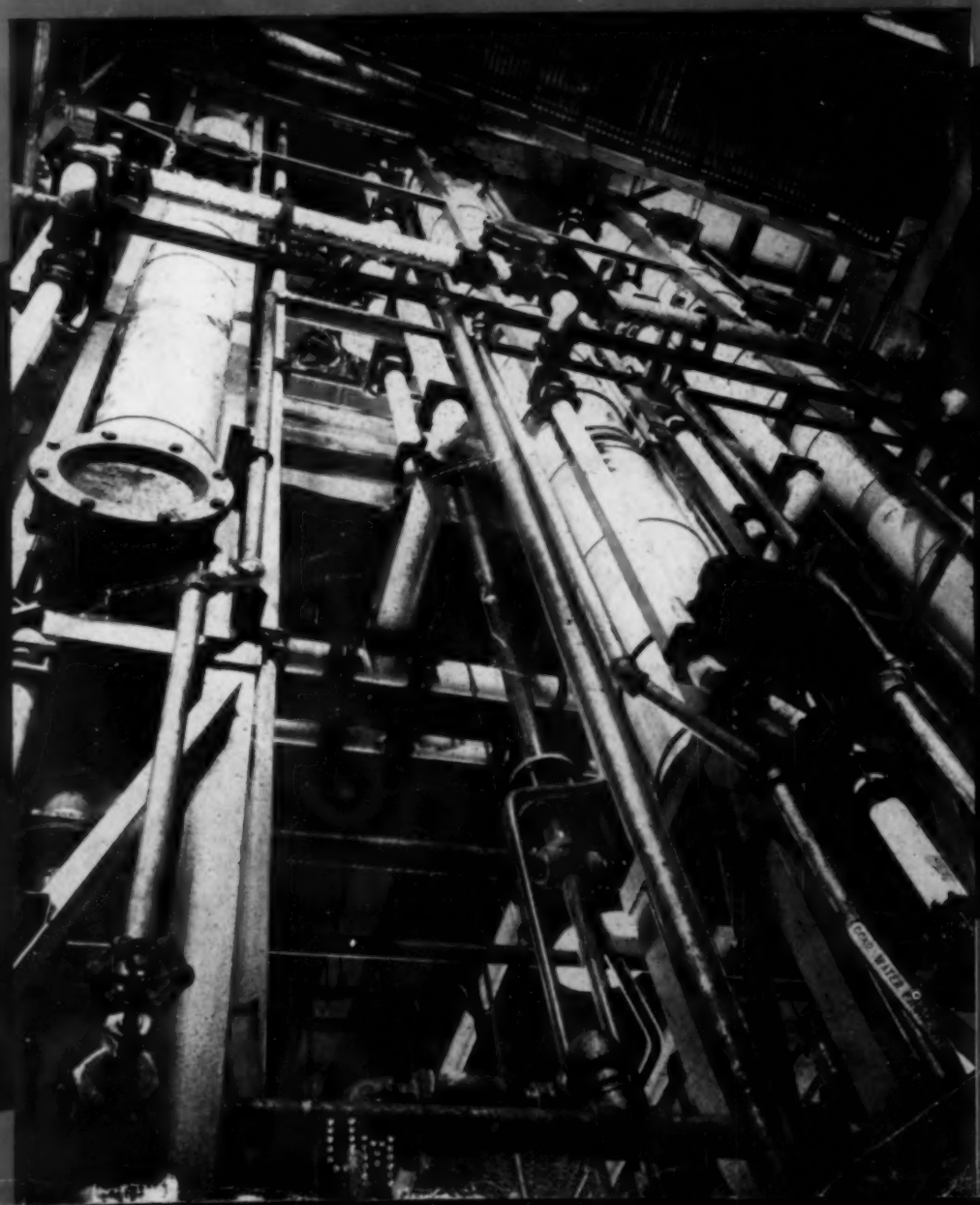
GRAW-HILL PUBLICATION



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Billion dollar processing problem solved by Continuous, Closed operation

MARGARINE, or lubricating grease, or shaving cream . . . Dozens of food, petroleum, and chemical products have this in common: They originate as a *liquid* which must be properly *congealed* with heat transfer and manipulation.

That's a billion dollar processing problem for a vast cross section of industry, most efficiently solved by continuous, closed VOTATOR operation.

The material is heated and/or cooled in seconds, safe and sanitary, *as it flows through the* VOTATOR *processing apparatus.* Scientifically determined agitation and perfect control over time and temperature precisely fix product texture, plasticity, and viscosity. Uniform quality is assured, at reduced processing cost.

VOTATOR apparatus does the work in often less than half the floor space required by open and batch methods, uses heat transfer medium with economy.

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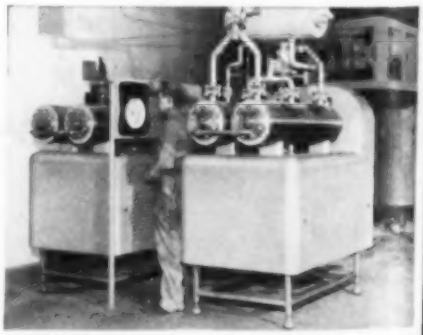

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for products such as Industrial Starch, Chemicals, Lard, Paraffin Wax, Vegetable Shortening, Lubricating Grease, Shaving Cream

CHEMICAL ENGINEERING

with CHEMICAL & METALLURGICAL ENGINEERING

Volume 54 Number 7

JULY 1947

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In This Issue

MORE Ethyleneamines NOW!

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The ethyleneamines are important as organic alkalies and as intermediates for many industrial compounds. With these materials, the way has been opened to product improvement and lower cost processes, in the fields of textile, pharmaceutical, resin, and petroleum chemicals.

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Ethylenediamine . . . intermediate for fungicidal chemicals . . . for pharmaceuticals, such as aminophylline, important for heart afflictions . . . for thermoplastic resins, such as norelac, a heat-sealing adhesive for packaged food, soap, and other merchandise.

Diethylenetriamine . . . manufacture of addition agents to improve spreading of oily substances on moist surfaces . . . an adjunct for bright copper plating.

Triethylenetetramine . . . for ion-exchange resins in water purification . . . as a softener in rubber reclamation.

Tetraethylenepentamine . . . for ion-exchange resins in sugar refining . . . as a rosin soap additive for preventing rancidity.

Aminoethylethanolamine . . . for finishing compounds to give fabrics a softer hand . . . for surface active agents, in ore beneficiation.

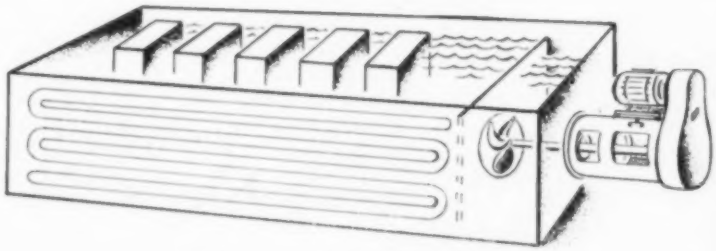
Additional information to determine which of the ethyleneamines can best serve your needs is contained in our "Nitrogen Compounds" booklet (F-4770). In writing for your copy, please address Department B-7.

CIRCULATORS

Laboratories of **MIXING EQUIPMENT CO., INC.**

The EQUIPMENT

SUGGESTED USES AND POSSIBILITIES



BRINE CIRCULATOR

The use of a propeller for brine circulation in ice making is a common application. Here the user from experience specifies the gallons per minute ordinarily at low heads from one to six inches, the result being faster heat exchange from ammonia coil to brine and from brine to the ice cans.

APPLICATIONS IN CALANDRIAS

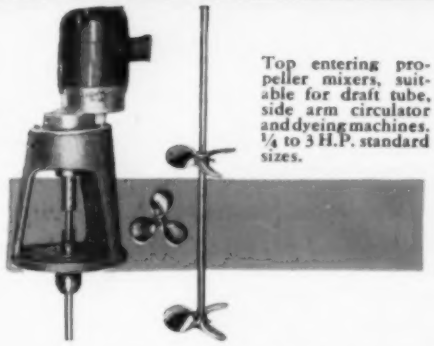
Applications in calandrias permit achievement of design performance by controlled velocity through the tubes. This offers the most exact method of predicting heat transfer performance in a closed vessel.

A SIDE ARM CIRCULATOR

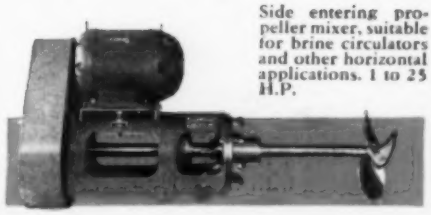
permits continuous additions of chemicals without short circuiting, or permits circulation for heat exchange purposes where the vessel has crowded coil conditions or unconventional heating elements, such as gas fired tubes, closely packed tube bundles, etc.

OTHER APPLICATIONS

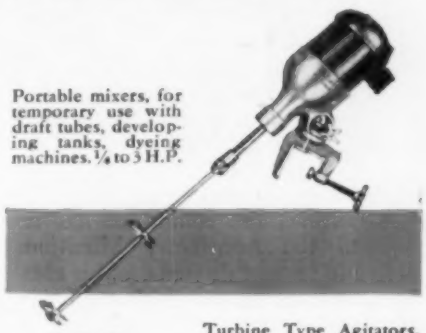
which suggest themselves include the use of the device in a draft tube, in a horizontal cylindrical tank to achieve a desired distribution of circulation, or in a vertical draft tube in a conventional vessel so as to produce a predicted velocity in the remaining part of the vessel as for heat exchange with coils or jackets.



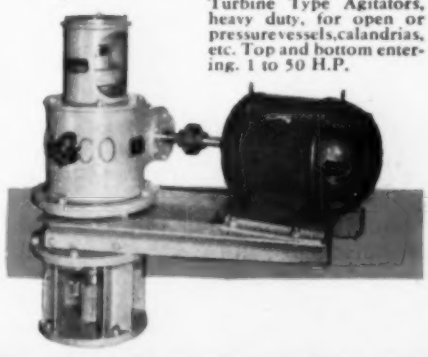
Top entering propeller mixers, suitable for draft tube, side arm circulator and dyeing machines. ¼ to 3 H.P. standard sizes.



Side entering propeller mixer, suitable for brine circulators and other horizontal applications. 1 to 25 H.P.



Portable mixers, for temporary use with draft tubes, developing tanks, dyeing machines. ¼ to 5 H.P.



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- ☐ B-68 and 68B Permanently Mounted Mixers for Pressure Vessels and Open Tanks
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WATCHING WASHINGTON

R. S. McBride, EDITORIAL CONSULTANT
Donald C. Loomis, WASHINGTON CORRESPONDENT

National rubber policy deferred . . . Chemical Corps plans to set up organized reserve units . . . Civilian group to take over guard duties at atomic energy projects in the west . . . New stream pollution study under way . . . International student exchange postponed until the fall of 1948 . . . Estimates of natural gas reserve reach an all-time high in Federal Power Commission report . . . New census will collect consumption data on chemicals . . . Puerto Rico gives tax holiday to new business . . . OTS will have funds to provide for orderly liquidation of its operations in Germany

Rubber Program

THE Armed Services Committee of the House of Representatives, is struggling along with the preliminaries that will eventually materialize as a bill spelling out a "national rubber policy." Heavily loaded with other high-priority legislative jobs, the committee has been confined to collecting data and recommendations from everyone connected with the rubber industry. Last month the possibility of holding hearings this session was dwindling rapidly.

Meantime, the committee has requested the Army-Navy Munitions Board to present its views, and is compiling returns on 1,000 questionnaires sent out around the first of June to government agencies, rubber manufacturers, rubber traders, and other elements of the industry.

"Armory" In Chemical Plant

ARMY Chemical Corps has plans for 89 affiliated units of the Organized Reserve to be sponsored by chemical manufacturers, oil refiners, commercial research laboratories and other organizations whose activities mesh with Chemical Corps wartime functions. Goal of the Army-wide, industry-wide program is 2,500 Army service units sponsored by industrial or business organizations, Chamber of Commerce and other civic groups, which would become the "armories" for the Reserve Corps units. Chemical Corps part of this huge training program calls for 89 units totalling 423 officers and 10,284 enlisted men.

What the Army and the Chemical Corps want is swifter conversion of civilian reservists to active duty, abreast of the military requirements of their specialty and the latest civilian know-how that can be brought to bear. Chemical corps will organize its drive for sponsors through the six procurement districts that already have close contacts with the potential sponsors in its area.

Atomic Commandos

GUARDING atomic energy projects, especially in the West, must be undertaken by a civilian group developed with training like that of the wartime Commandos. This decision has been announced by Atomic Energy Commission which has found that the Army is not in position to supply it with a sufficient number of troops to maintain the safeguards desired.

Recruiting is beginning in the West. The civilians hired will be given extensive physical training about equivalent to that of the special wartime Commando troops. After six months, they will gradually replace the Army guards in both internal and external care of the western facilities.

New Pollution Study

A SPECIAL research project of interest to the chemical industries that have a problem of waste disposal will be carried out this summer by the Interstate Commission on the Potomac River Basin and John Hopkins University. Particular attention will be paid to evaluation of the changes that take place in various types of sludge deposited in the bed of a fast-moving stream. The Commission undertook this study because of a lack of information on the subject, in contrast to the more extensive studies that have been made of the recovery of slow-moving deep streams. The project will be carried out under the direction of Charles E. Renn, professor of sanitary engineering at John Hopkins, Baltimore, Md.

Much of the work will be done in the vicinity of Cumberland, Md., where stream pollution from industrial and mining operations, as well as municipal sewage, offers a problem. Studies will be made also in streams where only one type of waste is encountered. Further research is planned on the effectiveness of low overflow aeration barriers built of rock readily available in the stream. New gaging stations and sampling stations are being set up along the Potomac. Industrial plants located in the Potomac basin will set up the sampling stations and test the samples obtained.

The Commission is publishing a waste treatment guide of interest to both municipal and industrial officials interested in pollution problems, since it covers treatment of both kinds of wastes. The booklet, when available, can be obtained by writing Edwin R. Cotton, Engineer Secretary, Interstate Commission on the Potomac River Basin, 520 Transportation Building, Washington 6, D. C.

Student Exchange Bogs Down

INTERNATIONAL exchange of students and professors under the Fulbright Act isn't likely to materialize until the fall of 1948, according to State Department officials in charge of the program. Complex legal and technical questions have to be agreed upon by the U. S. officials—and then the details have to be worked out with the countries in which credits have accumulated from the sale of surplus property. This procedure, required under the terms of the law, is time-consuming.

However, the State Department has submitted an agreement to China for consideration—and when negotiations (which haven't yet begun) bring the agreement into force, it will serve as the model agreement on which similar programs with other countries will be

E. Eng
Copy 2

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Cut MIXING COSTS 30% or more

One way to reduce material handling costs is to eliminate the extra step of emptying drums into mixing units.

Wherever mixing can be performed by revolving or tumbling the container, "U. S." Drum Mixing equipment can save you time and money.

"U. S." Drum Mixing equipment permits mixing in your own or supplier's drums . . . avoids the costly delays from emptying and cleaning fixed containers . . . eliminates danger of contamination.

AVAILABLE
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While our present supply of highly scarce motors lasts, we can make prompt shipment of certain size units. Write or wire for details.

DRUM ROLLERS

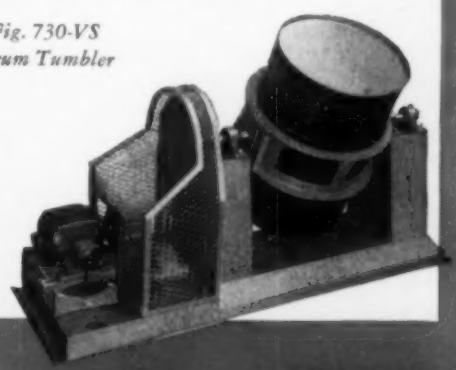
"U. S." Adjustable Drum Rollers will roll any round container from a one-gallon pail to a 70-gallon drum. Eight heavy-duty rubber wheels are adjustable to provide ample clearance for rolling hoops and bung openings. Powerful, heavy-duty motor will roll loads up to 1,000 lbs. "U. S." Drum Rollers are built in sizes to handle one, two, three, or four drums, constant or variable speed drive.

Fig. 745-S
Drum Roller

DRUM TUMBLERS

"U. S." Drum Tumblers are built in two sizes: single and double drum units to handle standard 55-gallon drums. Units to handle 30- or 70-gallon drums are available on special making order. Variable speed drive permits tumbling speeds from 8 to 21 RPM. Powerful, heavy-duty motor will handle loads up to 1,000 lbs. Adjustable yoke opens quickly and easily, locks securely.

Fig. 730-VS
Drum Tumbler



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PROCESS EQUIPMENT DIVISION

U. S. STONEWARE
Akron, Ohio

based. China has $20 million earmarked for the exchange—but her shaky currency and her economic distress are obstacles to realization of the program.

Appointment of the Presidential Board For Scholarships, which will administer the program, was awaited last month as an essential step which would tend to further the whole exchange program. The 10-man board will include representatives of government, veterans, and other groups besides the universities, thus limiting the possibility of strong representation from the technical schools.

Gas Reserves Estimated

ONE OF the first staff findings of Federal Power Commission as a result of its natural-gas investigation (Docket No. G-580) is a report estimating the natural gas reserves of the United States. This has substantial importance for process industry, as is evident from the following two paragraphs from the introduction.

"The natural-gas reserves of the United States have been estimated, as of January 1, 1946, to be in excess of 144 trillion cu. ft.—an all-time high. It is not generally realized that the known recoverable gas exceeds in heating value and approximately equals in weight the known recoverable oil reserves. The economic importance of natural gas is increasing. It is not only valuable as a convenient and economical fuel, but advancing technology suggests its utilization as a raw material from which substantial quantities of motor fuel and synthetic chemicals for the future may be made."

"Interest in gas reserves is no longer confined to local areas. A rapid expansion of large transmission lines linking the various fields to distant markets has tended to integrate supplies of gas and to make the problem increasingly a national one. The widespread use of gas as a fuel, its function in providing feed stock for the chemical synthesis of many products and its potentialities as a source of motor fuel have gained for it an important role in our economy. It is, therefore, of vital concern that the available supply of this natural resource be appraised periodically and the trends in new discoveries as compared with withdrawals be reviewed."

Census Shapes Up

CENSUS officials organizing the Census of Manufactures emphasize that any suggestions for changes on tentative schedules circulated in the industry should be made by the end of August at the latest. At that time, it's expected that Census will have to make the final decision as to how much of the tentative program can be put into effect. They will be limited by the amount of money finally voted by Congress.

Last month, there were about 20 different schedules for special chemical groups besides the main schedule (MC19F) on "Inorganic and Organic Chemicals." If a cut is necessary, Census officials will have the choice of eliminating items from schedules, dropping entire schedules, or both—but it can't be forecast what course is likely to be followed until the deadline is at hand.

Synthetic organic chemicals data now collected annually by the Tariff Commission won't be duplicated by Census Bureau. The Census form will ask for a single dollar value figure for sales and shipments for a group of about 15 of these chemicals—but will ask no further breakdown. This figure can be taken directly from the Tariff Commission report regularly filed by companies producing synthetic organic chemicals. Similarly, Census won't cover the field of chemicals for which figures are now collected by the Bureau of Mines.

Consumption Data Sought

A COMPLETELY new departure in Census-taking will be the attempt to get consumption figures on a number of basic chemicals such as sulphuric acid, caustic soda, and soda ash. The schedules for the steel or auto industry, for instance, will contain a section asking for the company's consumption of these basic chemicals. When the data is assembled, the chemical industry will have for the first time, information on the distribution and use of basic chemicals by the important consuming industries. Census officials circulated a list of 30 chemicals from which they will select those to be included in the final group for which consumption figures will be collected. Perhaps a dozen chemicals will be covered.

Census officials have a complex job in covering completely the chemical industry which has changed so much that the 1939 census is not a reliable guide. Efforts are being made to request information on production of chemical commodities by producers who were perhaps marginal in 1939. As an example, petroleum refiners will be asked for figures on their output of insecticides; this information was not asked them in 1939.

The outlook is for the Census forms to go to the printers about September first to be ready for mailing to manufacturers after the first of the year. As before, Census will send technical men to the larger companies to speed the job of filling in the forms accurately. Forms mailed out to smaller companies will be accompanied by a covering letter of instructions. Census officials emphasize the importance of the forms being filled out accurately.

Tax Holiday

TO INDUCE development of new industrial projects in Puerto Rico, the Insular legislature has passed and the governor has signed a bill providing for new industry "a blanket exemption from income, property, and municipal taxes as well as excise levies on machinery and raw materials. The most extraordinary feature of this legislation is the fact that no income tax (neither Federal nor Insular) will have to be paid by industrial enterprises established on the Island after July 1, 1947."

Government into Business

GOVERNMENT would be put extensively into the fertilizer business under the bills which had ardent support during May and June by Interior Department and Tennessee Valley spokesmen. The measure on which the Senate has held a series of hearings is S. 1251; and its companion measure which the House will consider is H.R. 2494.

These measures originated in American Farm Bureau Federation after consultation with the two government agencies, Interior and TVA. They represent the big effort to be made in this Congress for getting a further extension of the Valley Authority idea in the West. As a consequence they have aroused not only interested industry, but also members of Congress from the Western States. The latter group has characterized the effort as "carpet bagging from the South into the Intermountain area."

Opposition to the measures, which appears to have been very effective with the Senate committeemen, has been led by National Fertilizer Association and American Plant Food Council.

Farm Groups Split

ALTHOUGH American Farm Bureau Federation formulated this fertilizer bill and has aggressively supported it, there has been vigorous opposition from other farm groups. National Grange is outspokenly opposed to this entry of government into fertilizer manufacture. A large majority of the

co-ops also are opposing the bill. Since one or two of the co-ops have not wanted to come out aggressively against AFBF, the National Council of Farmer Cooperatives has not been able to act as a group. Before that group can embark on a legislative project of this sort, it is necessary to have unanimous support of all member co-ops.

Also vigorously opposed to the bill as drafted has been the Department of Agriculture, with personal leadership by Secretary Clinton P. Anderson. He made a strong personal appearance before the Senate committee criticizing any measure of this sort which would put the government further into business in competition with industry. After expressing vigorous opposition to the bill itself, he stated the position of the Department on fertilizer policy as follows:

"I do not favor S. 1251, but I do favor legislation to carry out various purposes and measures which are included in the bill. I favor the establishment of a national fertilizer policy and program. I favor the testing and demonstrating of liming materials, fertilizers, and other conservation materials as means of improving our farming systems on a nation-wide scale. In doing this I favor the use of existing agencies and representative advisory committees. I favor the exploration of fertilizer resources on public and private lands. I think it is extremely important to make sure farmers are able to obtain adequate supplies of fertilizer and liming materials at reasonable prices."

Cheaper Patents Asked

CONGRESS has been asked by American Patent Law Association to make patents cheaper. Referring to the pending bill H.R. 2320, the board of managers of the Association took formal action which has communicated to Congress making four requests: "That the filing fee be reduced to $15.00; that the final fee be eliminated; that the cost of printed copies of patents be reduced to 5 cents; and that the purpose of reducing fees shall be to facilitate the issuance of more patents so as to procure and disseminate information as to new inventions. The Patent Office public search files are to be considered as being one of the greatest, if not the greatest, sources of information in the world, from which the public should benefit."

Refrigerant Test

FROZEN food storage and transport has been handicapped by scarcity of adequate refrigerator cars. The Department of Agriculture is seeking to aid in the correction of this difficulty so that more satisfactory frozen-food business can be developed. For this purpose, it recently participated in the test of a special refrigerator car which, it is hoped, may be one of the forerunners of more extensive iceless refrigeration for both truck and rail transport. The Department describes this particular series of tests as follows:

"The car in which the tests were conducted has 3-inch insulation and is equipped with a split-absorption system of refrigeration, an adaptation of a well-known method of refrigeration. Tanks attached to the underframe of the car hold the refrigerant, anhydrous ammonia, under pressure. Cooling is achieved as the ammonia moves from the tanks through a single regulating valve and expands in the cooling coils located in the ceiling of the car. When the ammonia has completed its refrigerating effect, it is finally taken up by water in absorber tanks also attached to the underframe of the car. There are no moving parts."

President Asks Research

PRESIDENT TRUMAN has let it be known vigorously that he believes industrial research should be increased over the next five years, perhaps as much as doubled. This recognition of the responsibility of business management to be forward looking apparently has come from the preliminary results of President's Scientific Research Board. He thus takes a stand in favor of more extensive industrial investigations regardless of the extent to which government may do fundamental work, for public health, national defense, and other purposes.

President's Scientific Research Board reports were scheduled to go to the Chief Executive during June. All of these have been delayed because the Board executive officer, J. Donald Kingsley, was sent by the President to attend the Geneva meetings of International Labor Office. It is not contemplated that the staff reports, which are near completion, will be transmitted to the President or released to the public until sometime in August, after his return.

Research Bill Delayed

ENACTMENT into law of the National Science Foundation is not likely to occur for nearly a year more. It seemed barely possible that plans for that legislation might be speeded up in the House during late June, but final adjustment with the Senate-passed measure involves complications not likely to be eliminated before summer recess of Congress. As in the last Congress, the Senate seems much more aggressively in support of this new agency. The House in general offers no opposition, but does lack aggressive leadership capable of pushing the measure forward to early enactment. Most of the glamour surrounding the bill in early days disappeared with the creation of Atomic Energy Commission.

Recent forecasts are that ultimately Congress will get around to the passage of this bill, so that a Foundation of 24 members can be set up about July 1, 1948. In order to get passage of the bill, it seems likely that backers will have to accept the thought that a substantial part of the appropriation made must be distributed by States. That "pork-barrel" feature may not do serious harm to the effectiveness of the program; but it has been a very bitter pill for the "pure science" backers to swallow in order to get Congressional O.K.

As passed by the Senate, the bill under consideration in the House Committee includes also specific requirements for certain special health committees, dealing with cancer, heart disease, and the common cold. Critics say that these requirements are wholly unnecessary, but will not handicap the Foundation.

Atomics Move Slowly

WASHINGTON continues to guess regarding the speed with which atomic energy projects will develop. Especially noted lately has been the comments in a recent address by Dr. J. Robert Oppenheimer of AEC staff. His guess is that it will take 30 to 50 years before "atomic power can in any substantial way supplement the general power resources of the world. That is under the assumption that development is pushed, that intelligent and resourceful people work on the job, that money is available for it."

Ships to Blame

INSURANCE underwriters have concluded that the chemical industry was not at all to blame for the Texas City disaster. The fault lay "wholly" with the ships, which caused the major damage when they exploded. This is the report to the insurance companies made by George Armistead, Jr., a consulting chemical engineer of Washington. Among other things, his report says:

"The cause was wholly from the explosions of the two cargo vessels which both disintegrated at the Texas

CHEMICAL COMMENTS

Dow Glycols Enter The Electrical Field

The five Dow Industrial Glycols, products of many-sided importance to a variety of industries, have extended their usefulness in the past few years into the electrical field. Modern small dry electrolytic radio condensers are made possible by virtue of the fact that glycols will dissolve appreciable quantities of boric acid. Diethylene Glycol is used successfully for this purpose, as it rates high as a non-volatile conductor that does not corrode aluminum.

Germicide Keeps Hydraulic Emulsions Bacteria-Free

The action of bacteria in the hydraulic systems of metal fabricating plants causes frequent shutdowns and costly hydraulic fluid replacements. This trouble can be eliminated by the use of as little as one part Dowicide A per one thousand parts of the soluble oil-water hydraulic fluid. This application of the Dowicides has been used with excellent results with other systems employing soluble oils.

Methocel Keeps Pigments Stable in Paints

Methocel (Dow Methylcellulose) is proving useful in many ways in the paint industry and especially to manufacturers of water-base paints. It keeps pigments from flooding, settling or caking, provides thickening and binding action, and also serves as a pigment disperser. Its protective colloid action insures emulsion stability. In addition, its controlled viscosity prevents undue penetration and assures excellent brushing characteristics.

Further information on any of these chemical developments is available on request.

50th Anniversary 1897-1947

City docks within about 16 hours of each other."

The report made to the Coast Guard by its board of investigation was of rather similar nature. The board found many evidences of neglect of suitable precautions which should have been observed in handling a potentially dangerous material. The neglect of ordinary safety precautions even went so far as to have the only signs warning against smoking in the ship and in the hold printed in French. This obviously was not helpful for Negro stevedores handling the cargo.

The only recommendation made by the board to the Commandant was that a special inter-departmental committee be established to "determine every aspect of the characteristics of ammonium nitrate, develop additional information relative to its hazards in transportation, handling, and storage."

A most intensive study of the ways in which ammonium nitrate can be made to explode was conducted for the Coast Guard by Bureau of Explosives of Association of American Railroads. That report and the other investigations all confirm previously well-established facts as to the difficulty of causing an explosion of this material.

Tax on Alcohol

MANUFACTURERS of food and medicinal products using ethyl alcohol as an ingredient have proposed to the House Ways and Means Committee that the tax on alcohol used for non-beverage purposes be lowered to $1 per proof gallon. Under the Revenue Code consumers pay a tax of $9 per proof gallon but are permitted a drawback of $6 after the alcohol is used in the manufacturing.

Proponents of the amendment would like to be free of this drawback feature, that is, they would prefer to pay the tax (whether it be the present $3 rate or the proposed $1 rate) without having $6 additional per gallon tied up in the Treasury until such time as drawback applications are processed.

This, they claim, is burdensome, in that it ties up a total of about $12 million of their capital.

The Treasury's attitude against reduction of the tax and elimination of the drawback isn't likely to change, unless proponents come up with what Treasury would accept as a foolproof barrier against diversion of alcohol to beverage uses. The food, flavor, and medicine producers note that only 1,263 companies are now affected by the tax law, and that this small number would be easily policed. A stiff bond posted with Treasury, plus threat of withdrawal of permit, would be adequate insurance, in their opinion against widespread diversion of the alcohol to beverage purposes.

Curtailment of OTS

THE FATE of the Office of Technical Services, Department of Commerce agency distributing technical information from German industry, appears to have been defined by House and Senate Appropriations Committee members. Having at first been refused any appropriation whatsoever for fiscal '48 by the House, OTS and Commerce officials were later assured that funds will be given them to provide for an orderly liquidation of their operations in Germany.

This means that the documents in Germany that have been microfilmed or ready for microfilming will continue to be processed and shipped here. If no funds at all were provided, OTS would have had to cease all operations, box up all records for storage, and bring their personnel home. The outlook, too, is that OTS will be able to carry on its cataloging, evaluating, and publishing of technical reports, although on a much smaller scale than was provided by the $3.7 million the Office had in fiscal '47.

Barring unforeseen opposition to a minimum program recommended by House-Senate conferees, it appeared last month that $1 million might be made available to carry on classifying, indexing, and abstracting, even though on a more limited scale than heretofore. On the strength of these assurances, OTS personnel in Germany are given until October 31 to wind up their work. All original investigations and accumulation of information was to cease June 30.

Meanwhile, nearly 200 technical societies and industrial firms have volunteered to cooperate with OTS in evaluating, and screening on "raw information" from Germany. OTS last month was preparing to distribute documents to these groups, but awaiting final word from Congress on appropriations before putting this cooperative program into effect.

New Minerals Survey

HAVING taken a lot of punishment for its proposed 20-year, billion-dollar inventory-taking of U. S. mineral resources, the Interior Department has handed the problem to Congress. It did so by submitting a purely factual report on the mineral self-sufficiency of the U. S.

The report (copies of which aren't yet available, except for inspection) makes three comparisons for 39 minerals: domestic production compared with domestic consumption; U. S. commercial reserves compared with annual rates of production and consumption; and percentages of measured, indicated, and inferred reserves in the total estimate of commercial reserves.

The report has been given to the subcommittee of the Public Lands Committee which is studying the need for a national minerals inventory.

Minor News Glimpses

Structural insulation board is an important new division of process industry serving the construction business, according to Department of Commerce. Estimated production in recent years is about 1.7 billion sq. ft. with important markets, as described by the construction division in a recent "Industry Report."

National Bureau of Standards reorganization has been tentatively completed, taking effect during June. Changes are largely a re-grouping of technical sections, with much less emphasis on optical research and much more on atomic physics, radio, and ordnance development.

Imports from Army-occupied areas are still managed exclusively by U. S. Commercial Co., a subsidiary of RFC. Recently a few commodities of interest to process industry have begun to trickle in through this channel, including menthol crystals and camphor.

Dusting of potatoes in refrigerator cars before movement through areas where Japanese beetles exist has proven a safe procedure to prevent movement of that pest out of quarantined regions into uninfected areas. Potatoes so treated carry from the car only unobjectionable traces of DDT. Simplification of quarantine rules is expected.

A dye test permits determination of maturity of cotton fibers, according to a report of Southern Regional Research Laboratory. Interpreters suggest this implies certain dyes give variable performance in the textile industry when variable maturity of textile fiber is encountered. Thus it suggests both maturity control and need for investigation of dye performance industry.

One-ton chlorine containers still are available for lease from Chemical Warfare Service. These are suitable for any readily condensable gas for use on either truck or railroad transportation carriers. Interested industry is asked to consult with the Contracting Officer, Chemical Corps, Edgewood Arsenal.

CHEMICAL ENGINEERING
with CHEMICAL & METALLURGICAL ENGINEERING

ESTABLISHED 1902 JULY 1947 SIDNEY D. KIRKPATRICK, Editor

Whose Recession—and When?

ASK almost any business man about the prospects for a recession this year and the chances are his answer will be in terms of the other fellow's business. His own is in pretty good shape. He sees no very threatening clouds on his horizon—orders are still holding up, customers are planning to expand their operations, prices are high and yet no serious resistance has developed among the buyers. But we all know that business recessions have a way of surprising most people. Optimism is an unstable element, quickly affected by a change in the business cycle.

Most observers see a fairly favorable future for the chemical industry during the next six months or so. Standard & Poor's latest survey expects chemical production to hold up better than general business. "If the over-all decline (in general business) from the first quarter high does not exceed 20 percent, as currently expected, the impact on the chemical industry should be relatively unimportant." Sharpest declines are expected in chemicals used in textiles (particularly in cotton mills), in pulp and paper, paint and tires. Yet chemicals are so widely used throughout industry, and so many new products and uses have been developed that a strong market is likely to continue for some time to come. Both sales and profits should, says this report, set new high records in 1947.

Nevertheless there are plenty of signs that the current situation is none too healthy. Over-all efficiency is low, both in manufacture and distribution. Labor's productivity is still down and its costs are mounting. New plant capacity is slow in reaching completion and capital investment far exceeds estimates of only a few months ago. Inventories are increasing both in volume and value.

Some observers regard business failures as a sensitive index of trouble ahead. Certainly we can recall the high mortality of chemical enterprises that followed in the wake of World War I. Turning upwards in 1920, failures reached a rate of 19.8 per 1,000 businesses in the chemical industries in 1922. Beginning in 1940, according to a recent study by Dun & Bradstreet, that rate dropped consistently to 2.1 in 1944 and 1945 and then increased slightly last year to 2.2. During the first quarter of 1947, however, failures among chemical producers exceeded the total liabilities of the entire year of 1946 by more than 30 percent. Only the iron and steel groups showed a higher failure index. Yet certainly that is far from reaching any alarming proportions.

In the face of these conflicting signs and signals, prudent management is going to take steps to strengthen its position and prepare for the time when survival may depend upon lower costs in manufacture and sales. Advantage must be taken of new techniques and equipment. Production and engineering staffs must be strengthened and provided with facilities for effecting savings in material and labor. Selling organizations that were weakened by the war must be built back in numbers and ability in preparation for the job ahead. Even research can be made more productive if all hands concentrate on the objective of showing results that can readily be translated into profitable products and processes.

Such wholesome practices do not and should not depend upon any anticipated changes in the business cycle. Even if business activity in our field continues at its present high levels, there are marked advantages in being prepared for the inevitable period of greater competition that will come once supply exceeds demand. There is no better way to safeguard the future status of the chemical industry than to improve its present.

FLEXIBLE PLANS FOR FERTILIZER MAKING

General view from lake of fertilizer plant of International Minerals & Chemical Corp, Hartsville, S. C.

RUSSELL S. McBRIDE
Editorial Consultant, Chemical Engineering, Washington, D. C.

FLEXIBILITY IS ESSENTIAL FOR CONSTANT CHANGES OF RAW MATERIALS AND IN GRADES AND FORMULAS

FERTILIZER making does not look difficult to a chemical engineer when the plant is properly planned and operated. Actually the complexity of process control is cleverly concealed by the apparent ease of operation under a skilled management which maintains the flexibility of operation essential to present day success. But this flexibility, which is essential for constant changes of raw materials and frequent changes in grades and formulas, represents a type of skill too little used in process industry generally.

The Hartsville, S. C., plant of International Minerals and Chemical Corp., here described and presented on the pictured flowsheet of this issue, is a new plant built in the midst of war difficulties by the company staff itself to replace a plant destroyed by fire on the same site. The factory is essentially one large frame building of exposed timber construction covering a ground area about 225 ft. by 420 ft.

This single building houses the superphosphate manufacturing equipment, materials storage, and all of the mixing and bagging facilities required. Ground phosphate rock, sulphuric acid, ammonia solutions, and the various dry nitrogen carriers, potash salts, and other materials are received ready for use. Outbound are mainly complete fertilizers, bagged either for truck or rail shipment and in small part shipped in bulk in box cars to a few customer mixers, who in turn care for neighborhood trade in the area served by this plant.

In this simple but comprehensive installation a crew of about six men serve to make superphosphate. Another crew of twelve can operate either of two mixing units for bulk shipment or for stockpiling in the complete fertilizer bins. A crew of about 20 is needed when fertilizers are being made and bagged simultaneously. Incidentally, this plant prints its own bags with a two-man crew which also as well maintains bag stocks and serves bagging crews.

The smart superintendent demands his own printing press as an essential to plant flexibility. Each day the assistant superintendent lays out the program for the following operating day. He figures just the tonnage of

Fertilizer making requires more skill in quick adjustment of plant from hour to hour and day to day than it does skill in difficult chemical engineering problems. But closely controlled operations are needed not only for batch making to meet legal grades, but also to insure that a whole operating crew is not long out of action during change-over from one formula or grade to another. There is still required plenty of skill in labor management, for a plant must function with precision in the hands of comparatively unskilled personnel. Rightly organized, a small crew handles a substantial tonnage of materials at low cost.

each grade or brand which will be manufactured or packaged for shipping. Then the bag-house crew of two gets instructions as to just how many cloth bags and how many paper bags are to be imprinted with the corresponding formulas. They have the printed bags ready for use at the bagging machine when the crew comes in the following day. The plant office simultaneously assembles the requisite number of analyses and tax tags, so that each package gets its correct State tags which makes it eligible for movement out of the plant.

This adjustment of daily plans, according to orders which can be shipped, requires the utmost adaptability on the part of the operating staff. Frequently several different formulas must be packed in a single day. Every move to permit quick change-over from one formula or grade to another is essential so that there is a minimum of time wasted. A substantial portion of operating profit is lost if this change-over cannot be worked out in minutes.

Superphosphate Making

Conversion of phosphate rock to superphosphate takes place in about one minute when fine ground phosphate rock is dropped into the reaction pan containing 54 deg. Bé sulphuric acid at approximately 110 deg F. A typical charge is approximately one ton of rock containing 75 percent "bone phosphate of lime" (tricalcium phosphate) which is dropped into nearly an equal weight of acid in the cast iron pan and stirred vigorously with cast iron paddles. In something less than a minute the soupy mix is dropped through the bottom of the pan into the "den." The batch reaction is repeated at one-minute intervals for about 25 cycles until the den is full.

The reaction in the pan converts the tricalcium to monocalcium phosphate. A considerable part of the fluoride in the rock reacts with the acid to form HF, which in turn reacts with silicates to form SiF_4. This is evolved in gaseous form together with much of the water from the acid which evaporates because of the heat of reaction. The weight shrinkage during reaction is about 10 percent.

The steam and acid fumes are pulled from the top of the den and the reaction pan by a fan which forces them outdoors through a four-tower condensing and cooling system. Water is sprayed in the first three of the towers, forming an acid condensate. This is re-circulated by the pumps which feed the sprays until it reaches a strength justifying discard into a nearby settling pond.

Rock for this operation is received at Hartsville in large closed hopper-bottom cars which carry over 70 tons per car. The rock is ground 50 to 52 percent through 200 mesh screen. Handled in closed cars, it slides readily from the hopper bottoms into the track hopper, from which it is conveyed and elevated either to the rock storage bin or to the ground rock bin over the weigh hopper of the reaction pan.

Operations at Hartsville are so closely scheduled that normally the vast majority of the rock goes directly from the track hopper into use. At times the ground rock storage bin remains practically empty for many days at a stretch, because the making of green superphosphate is carried out just as rapidly as the arrival of rock permits.

This would be an intolerable arrangement if regular rock deliveries could not be counted on. These are possible because the company mines its own rock, and it is handled by a single railroad direct from Mulberry, Fla., to this Hartsville plant. Incidentally, the cars used are a special sort built for this service. Closely scheduled handling is feasible under normal transportation conditions.

Cutting and Curing

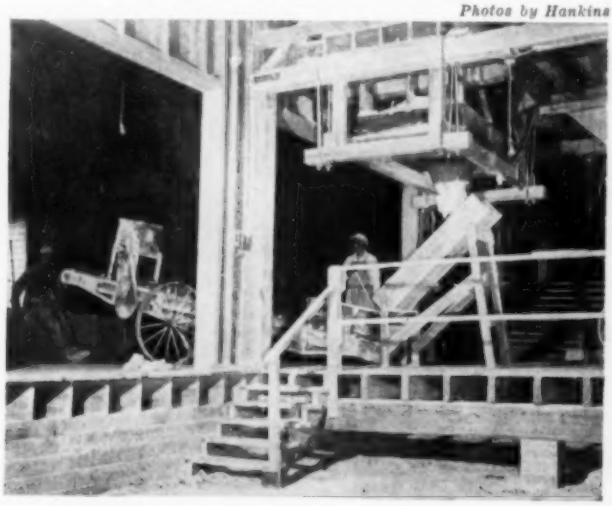
After about 25 charges of superphosphate have been dropped into the den, and allowed a few minutes for setting, the den door is lifted, and the cutter starts to remove green superphosphate from the den. This cutter is a vertical shaft with hook-like arms that revolve into the den mass which is already set up into a semi-solid form which could be removed with difficulty by hand tools. As this superphosphate is cut away from the den mass, the back wall of the den moves forward pushing the superphosphate against the cutter until all of it has been removed into the cutter hopper.

From this hopper the lump and fine material is elevated to a rubber conveyor belt system close to the ceiling and carried along to the point on the storage floor where the next pile is to be made for curing. The green superphosphate again sets up fairly hard in these curing piles where best practice requires it to stay for three to six weeks. Actually most fertilizer makers cannot, with present excessive demands, leave it in the curing pile nearly as long as they would like because of the insistent demands of cus-

Digging mixed fertilizer from curing and storage bins for bagging or bulk shipment

Loading bulk shipment of mixed fertilizer from base of mixer system after final screening and mixing

Photos by Hankins



tomers for deliveries. Curing can be hastened by rehandling and aerating, which is done with tractor shovels, truck tractors and overhead dump cars. Shipments are now made with complete success after intervals which must make the old fashioned fertilizer man groan or turn over in his grave.

When cured, the superphosphate made at Hartsville analyzes 19 to 20 percent available phosphoric acid (P_2O_5). Usually the material has about 2 percent free phosphoric acid, 6 to 8 percent moisture, and 0.5 percent of insoluble. This is the standard superphosphate of present operations in practically all acidulating plants in America. Almost none makes super of less than 18 percent, and few make any over 21 percent.

Complete Fertilizer

The cured superphosphate in the pile on the curing floor is just one ingredient of the prospective mixed fertilizers which go to the farmer. All of the other plant food materials used in the formulas reach Hartsville in box car quantities, and are unloaded with suitable power equipment into the storage bins which provide for about 15 to 20 materials in quantities up to several hundred tons each. All of these other materials are in physical form ready for mixing.

When mixing starts, the superphosphate has to be broken down with light blasts of dynamite so that the power shovel can pick it up and load a truck tractor, which conveys the superphosphate over the larger floor scale to the mixer hopper. Small hand-operated hopper trucks bring the other materials in the required quantity over a smaller floor scale to the same mixer hopper. Most complete fertilizer formulas require eight or ten ingredients. Each of these ingredients must arrive in exact quantity at coordinated intervals, so that each batch of 1.5 tons can be hoisted as a unit from the floor hopper to the top mixer hopper over the clod breaker. Since batches follow one another at intervals of about one and a half minutes, it is evident that real teamwork is needed on the part of the 12 to 15 men who operate as the mixer crew. On the ground floor the weigh master supervises. Upstairs the mixer operator is in charge. These two communicate by bell signals, and keep operations under control.

The clod breaker serves to crush by a small stiff arm hammermill any lumps that have come up in the superphosphate. This breaker discharges the mixture directly into the rotary screen from which the properly sized material is collected in the batch hopper which feeds the mixer. Any oversize material from the screens drops into a grinding mill, and returns to the system.

The mixer is a baffled shell rotating on a horizontal axis. It serves to get adequate mixing of the one and a half ton charge in much less than a minute. This is true whether the mix is to be ammoniated or not. If it is so treated, the ammonia liquor sprays in while the mixture is tumbling, in an accurately gaged quantity from the ammonia tank located nearby where it can be manipulated by the mixer man.

The output of the mixer is finished fertilizer ready for final curing. It is elevated to the top floor, from which it is carried by belt conveyor and overhead car system to the appropriate bin for curing.

Shipment is made by power-shovel and truck-tractor movement from these curing bins, either to an elevator, screen, and hopper system used for bulk loading, or to an almost identical group which feeds the bag-filler and bag-closing system.

There are several advantages in storage of finished fertilizer for curing before shipment. To a limited extent further reactions occur, especially in ammoniated mixtures. Curing is necessary to assure a free flowing, easy to drill fertilizer. There is also the practical advantage of accumulating orders to concentrate shipping on a single grade or formula, which is more efficient than small lot processing. And, of course, substantial stocks of goods must be put into storage during periods of light demand, in order that there be a reserve for use when the planting season starts and orders are more plentiful. There is even an operating advantage, because a limited number of trained men can be kept over longer seasons if the same crew makes mixtures at certain times and handles bagging and shipping at other periods.

German Waste Treatment

Effluent treatment practices in some of the chemical factories of Germany were investigated by V. L. King and R. P. Parker for Technical Industrial Intelligence Division of U. S. Department of Commerce.

In so far as the I. G. plants located on the Rhine are concerned, they enjoyed the benefit not only of large dilution, but also the benefit of the fact that the river itself is very dirty. The Rhine also has considerable acid neutralizing power. Part of this alkali is said to come from effluents of the potash mines in Alsace, France. The alkali carried by the river could neutralize 7,257 metric tons of sulphuric acid per day.

Oxygen consumers, like SO_2, hydrosulphites, some organic chemicals, etc., were destroyed in the shops by chlorine treatment "at the source." As the chlorine was used only for very short times during the running of each such effluent, not much cost was involved. HCN was given special "treatment at the source." Small catch basins were built so that any liquor that might contain HCN could be treated with lime and copperas and allowed to settle before testing and decanting into the canals. Liquor was not permitted to be discharged unless it tested less than 0.01 milligram HCN per liter.

Tests in the Rhine have established that more "phenol" is discharged from the exhaust of boats using diesel engines than can be found in the effluent. The special attention to phenol is given because in the Ruhr area the coal mines and tar distillers are reported to put so much tar acids into the Rhine that the salmon acquire an unpleasant taste.

The scheme developed at Oppau for the aluminum chloride plant at Schkopau involved running the furnace gases which contain chlorine, carbon monoxide and dioxide, titanium tetrachloride and silicon tetrachloride, through wash towers in parallel with wash waters, then through two Schroeder disk washers fed with a thin milk of lime slurry. These could be used either in parallel or in series. A fan sucks the gases and also air for dilution on the way to a 30 yard high stack as vent. The wash liquors were bled off and mixed with waste milk of lime slurry and then run to the canal.

Lime waste produced at the Oppau buna works was pumped to settling basins. As the waste contained chlorides and other materials, the lime hardened by carbonation and oxychloride formation and became difficult to slurry up or mine hydraulically. This waste was hauled away and used by building contractors and farmers.

Orders for the report, (PB-49234: "Effluent Treatment Practices in some of the Chemical Factories in the French, British, and American Zones of Occupation in Germany"; photostat, $3; microfilm, $1; 39 pages) should be addressed to the Office of Technical Services, Department of Commerce, Washington 25, D. C.

PETRO-CHEMICALS

Threat or Promise?

EDITORIAL STAFF REPORT

IMPORTANT QUESTIONS AND ANSWERS THAT FEATURED THE DIAMOND JUBILEE DINNER OF THE MANUFACTURING CHEMISTS' ASSOCIATION

What about the future relations of petroleum refiners and chemical manufacturers? Does the former's large-scale entry into the latter's field presage destructive competition or constructive, coordinated and integrated service as a boundless source of chemical raw materials? Will the next few years see evolution or revolution in the markets for alcohols, solvents, resins and plastics, synthetic detergents and other chemical specialties? Will the oil industry continue to be a customer or a competitor for its own increasing requirements for many chemical products?

Pro's and con's on these and other related questions were ably presented to the chemical manufacturers at MCA's 75th annual meeting at Skytop last month by two young and brilliant representatives of the petro-chemical industry. H. W. Fisher, president of Enjay, Inc.—the newly organized subsidiary of Standard Oil Co. (N. J.)—spoke on "Petroleum as a Source of Chemical Raw Materials." George L. Parkhurst, president of Standard Oil of California's Oronite Chemical Co. dealt mostly with "Aromatic Chemicals from Petroleum." Both developed their subjects in a friendly, cooperative spirit that augurs well for future relations between these giant industries.

There can be no doubt about the oil industry's tremendous capacity for supplying chemical raw materials. Potentially it is a source of 85 billion pounds of benzene, toluene and xylene alone. The new hydrocarbon synthesis plants producing a modest 100,000 bbl. of gasoline per day from natural gas might make our entire prewar requirements of ethyl alcohol. During the war the refiners were turning out almost a billion pounds of butadiene per year for synthetic rubber. Cumene (isopropyl benzene) output for use in aviation gasoline reached about the same magnitude. In the solvents field petroleum and natural gas today account for 5 percent of the country's methanol production, half of the ethyl alcohol, all of its isopropyl alcohol, 75 percent of its acetone, 35 percent of normal butyl alcohol and 90 percent of the country's amyl alcohol. The major part of our total supply of xylene is already produced from petroleum and being utilized on an increasing scale in the manufacture of phthalic anhydride. Large quantities of acetic anhydride and acetic acid trace their origin to petroleum. The war demonstrated that toluol is no longer a coal-tar monopoly. A greatly increased output of benzol from petroleum is just around the corner. Cresylic acids are fully competitive. Synthetic detergents may have the edge even in the face of a rapid and continuing decline in the price of natural oils and fats.

H. W. Fisher G. L. Parkhurst

What's on the other side of the ledger? What's to keep the oil refiners from moving in and usurping the major share of at least the raw-material business in the synthetic organic chemicals? The petroleum industry itself knows the answers. It is primarily and preeminently a producer and marketer of energy in the form of liquid fuels. It realizes that the whole range of commercial chemicals and synthetic products that might be made from petroleum could utilize only a fraction of 1 percent of the world's crude oil production. By and large it is not set up to deal in highly refined specialties. It makes its money on large-volume, low-margin products. It sees no percentage in selling expensively purified hydrocarbons at the price of gasoline or their gaseous fuel values. Its technology changes so rapidly that it is reluctant to enter into the long-term contracts demanded by chemical customers. It has no desire to build up the substantial inventories of chemical raw materials that must be held for relatively long periods and therefore become extraordinarily expensive from the viewpoint of the petroleum refiner.

Finally, and not exactly an unmixed blessing, is the very substantial chemical engineering problems yet to be solved in making some of these materials available to chemical manufacturers in usable form. This applies particularly to the relatively large quantities of oxygenated compounds concurrently produced in the Fisher-Tropsch process of making liquid fuels from natural gas.

Here, in summary, is the way Mr. Fisher sizes up the inter-industry problem: "Without doubt, future possibilities are tremendous and by continuing the sympathetic and cooperative spirit which has marked past relations between these two industries, the future development can redound to the benefit of both. We do not think of the chemical activities of the petroleum industry as being in conflict with those of the chemical manufacturer, but rather as a relationship between raw material supplier and consumer... Constant change is the ever-present characteristic both in the chemical industry and in the oil industry. Together they will meet these challenges as successfully in the future as in the past."

75 YEARS OF AMERICAN

1872

M. C. A. organized—Borax discovered in Death Valley—Carbon black made from natural gas—Portland cement first manufactured in U. S.

1873

Paris green use increased by potato beetle

1874

Burcey Chemical Works, methanol refining—A. Klipstein, chemical importer—Water gas introduced

1876

American Chemical Society founded (*Journal* established 1879; *Chemical Abstracts*, 1907, *Industrial and Engineering Chemistry*, 1909)—Concentrated alum made, Pennsylvania Salt—Sulphonated oils manufactured, Turkey Red Oil Co. (now National Oil Products Co.)

1878

Glucose made from corn, Arno Behr, Jersey City

1879

Baker & Co., platinum—Saccharin discovered, Ira Remsen

1880

Fuller's earth used in refining cottonseed oil, and lard substitutes produced, W. B. Albright

1881

Lactic acid and lactates developed, C. E. Avery

1882

First byproduct sulphuric acid made, Matthiesen & Hegeler Zinc Co.—Natural gas used for melting glass

1883

Liquid nitrous oxide made, Lennox Chemical Co.

1884

Liquid carbon dioxide manufactured, J. B. Stobaeus—Sherwin-Williams Co., paints—Solvay Process Co. erected alkali plant, Syracuse

1885

Sulphuric acid manufacture improved, J. B. F. Herreshoff

1886

Aluminum prepared, C. M. Hall—Sodium by iron carbide process, H. Y. Castner

1887

Benzol, phenol, nitrobenzol made, D. W. Jayne—Petroleum desulphurizing patented, Herman Frasch

1888

Aluminum on commercial scale, C. M. Hall—Calcium carbide by electric furnace, T. L. Willson—Phosphate deposits discovered, Florida

1889

H. H. Dow organized Midland Chemical Co.

1890

Electrolytic process for sodium, Castner—Hot-water sulphur mining, Frasch

1891

Byproduct coke ovens introduced—Carborundum, E. G. Acheson—Merck of Darmstadt American branch, now Merck & Co.

1892

Michigan Alkali Co., ammonia soda process

1893

Caustic soda and bleaching powder by electrolysis, E. A. Le Sueur; Mathieson Alkali—Velox photo-printing paper, L. H. Baekeland—Wood distillation retorts charged with iron buggies, Matt Quinn

1894

Armour Fertilizer Works, C. H. MacDowell—Selenium ruby glass, Nicholas Kopp

1895

Barrett Manufacturing Co. formed of six coal-tar distillers, W. H. Childs

1896

Aluminum hydrate, Merrimac Chemical Works—Artificial graphite, E. G. Acheson

1897

Adrenaline isolated, J. J. Abel—Catalytic process for decomposing fats and oils, Ernst Twitchell

1898

Bleaching powder from electrolytic chlorine

1899

Columbia Alkali Co., soda-ammonia process—First chemical merger, 12 firms into General Chemical Co., W. H. Nichols—Tennessee phosphate deposits first worked

1900

Carbon bisulphide by electric furnace, E. R. Taylor—Sulphuric acid contact process, Herreshoff—Vacuum deodorizing of cottonseed oil, David Wesson

1901

Abbott Alkaloidal Works (now Abbott Laboratories)—Monsanto Chemical Co., John F. Queeny—Bureau of Standards

1902

Atmospheric Products Co. attempted nitrogen fixation, Bradley and Lovejoy—*Chemical Engineering* founded as *Electrochemical Industry*

1903

Consolidated Color & Chemical Co., H. A. Metz—Electrolytic Alkali plant, Penn. Salt

1904

American Dyewood (United Dyewood) and Seydel Chemical Co. founded

1905

Phenol-formaldehyde condensation products (Bakelite) discovered, L. H. Baekeland

1906

Electrical precipitation of suspended particles, F. G. Cottrell—Industrial Alcohol Act—U. S. Industrial Alcohol and Vanadium Corp. organized

1907

Calcium arsenate insecticide, J. B. Smith—Cyanamid produced by American Cyanamid Co.

1908

American Institute of Chemical Engineers (*Transactions*, 1908; *Chemical Engineering Progress*, 1947)

1909

Fertilizer interests merged in International Agricultural Corp.—Liquid chlorine, Electro-Bleaching Gas Co.—Texas Gulf Sulphur Co. began operations—Hooker Electrochemical Co. plant, Niagara Falls.

1910

Diamond Alkali Co., soda-ammonia process—Hydrogenation of vegetable oils, Procter & Gamble—U. S. Bureau of Mines

CHEMICAL PROGRESS

A chronology of the industry's outstanding developments, as prepared by Lawrence W. Bass and Williams Haynes for M.C.A's Diamond Jubilee.

1912

American Trona Corp. and Amalgamated Phosphate Co. (Ammophos) organized—Petroleum cracking developed, W. M. Burton

1913

American Agricultural Chemical Co. reorganized by merger—du Pont subsidiaries disassociated by court order into du Pont, Hercules and Atlas—Freeport Texas Co. produced sulphur — Mellon Institute

1914

Barium peroxide produced, Rollins Chemical Co. (now Barium Products Corp.)—*Chemical Industries* founded, D. O. Haynes—Pyrex glass, Corning Glass works

1915

Air Reduction Co. and Calco Chemical Co. formed—First Chemical Exposition—Gas-black used in rubber tires—High chromium iron alloys introduced—Sulphur black produced commercially, E. C. Klipstein & Sons

1916

Artificial leather commercially important—National Research Council—Warner-Klipstein Co. (now Westvaco) electrolytic plant, Charleston, W. Va.

1917

Mergers: du Pont-Harrison Bros.; Monsanto-Commercial Acid; National Aniline & Chemical Co. (Schoellkopf, Beckers, and Benzol Products)—Organic mineral-flotation agents—Pyrethrum extract in kerosene spray insecticides—Salvarsan, H. A. Metz Laboratories—Synthetic indigo produced in U. S., Dow—Chemical Alliance, Inc.

1918

Chemical Warfare Service organized—108 different coal-tar dyes made in U. S.—du Pont Deepwater plant—Phthalic anhydride produced commercially by vapor phase oxidation—Silica gel in refrigeration and absorption — Ammonia and cyanamid plants, Muscle Shoals

1919

Casein plastics—Chemical Foundation—Fermentation butanol and acetone, Commercial Solvents Corp.—Mercurial antiseptics

1920

Allied Chemical & Dye Corp. formed by General, Barrett, Solvay, and National Aniline—Pyroelectric production of phosphoric acid, Swann

1921

Anhydrous alcohol, U. S. Industrial Alcohol—du Pont entered rayon manufacture—Emergency dye tariff—Rubber latex directly utilized—Synthetic Organic Chemical Manufacturers Association formed

1922

Becker-type coke oven installed—Ethylene glycol, Carbide & Carbon Chemicals Corp. — Insulin discovered, Banting, and produced, Eli Lilly—Lead tetraethyl introduced as anti-knock—Synthetic ammonia plant built

1923

Duco, du Pont—Ethylene dichloride, Carbide; fermentation citric acid, Pfizer; amyl alcohol from pentane, Sharples—Hercules entered naval stores

1924

Catalytic oxidation of ammonia in manufacture of nitric and chamber sulphuric acids — Synthetic ammonia by Mathieson, du Pont, Hooker, Niagara Ammonia, and Atmospheric Nitrogen — Synthetic butanol, Carbide & Carbon

1925

Antioxidants for rubber—General Dyestuff Corp. (I.G.) organized, bought Grasselli Dye Dept.—Niacet Chemicals Corp. formed — Phenol from chlorbenzene, Dow — Solid carbon dioxide in refrigeration, Dry Ice Corp.

1926

Atomic hydrogen welding, Langmuir—Flotation process applied to phosphate rock — Cellophane and sausage casings—Synthetic methanol made in U.S. (Commercial Solvents and du Pont)

1927

Alpha-cellulose (Brown Co.), electrodeposition of rubber (American Anode), Glyptal resins (General Electric), and safety glass commercialized—Hopewell synthetic nitrate plant, Allied Chemical & Dye

1928

Alkali plants on West Coast (Hooker and Pennsylvania Salt) — Anhydrous and aqueous ammonia in fertilizer manufacture — Phosphoric acid production by blast-furnace, Victor Chemical Works—Shell Chemical Co. formed —Vapor-phase cracking of petroleum

1929

Battelle Memorial Institute — Diphenyl, Swann — Vinyl resins, Carbide & Carbon

1930

Alcohol and ethyl ether synthetically, Carbide & Carbon —Dichlorodifluoromethane as refrigerant, Midgeley

1931

Duprene and synthetic drying oil introduced, du Pont—Polyacrylates, Rohm & Haas—Potash first shipped from New Mexico, American Potash Co.—Standard Chromate Division, Diamond Alkali, in production

1932

Patents upheld on butanol (Weizmann), catalyst (Selden), and lacquer (Flaherty)—Plastics produced in increasing variety (Alkyds, Aroclors, Beetle, Catalin, Cellophane, Haveg, Marblette, Plaskon, Plioform, Pliolite, Styrol, Thiokol, Tornesit, Vinylite, etc.)—Standard Alcohol Co. formed—Vitamin C isolated, C. G. King

1933

Chemical Alliance revived to draft NRA code—Chlorinated solvents developed commercially—Polymethacrylates—Solvent refining of lubricants—Synthetic camphor, du Pont—T. V. A. created

1934

Alkali plants in the South: Southern Alkali, Corpus Christi; Mathieson, Lake Charles; Solvay, Baton Rouge —Bromine from sea-water, Ethyl-Dow Corp.—Diphenyl oxide developed as heat transfer agent—Iso-octane as aviation fuel—Salt cake and soda ash from Searles Lake, American Trona Co.

1935

Chemurgic Council organized—Ethyl cellulose, Hercules

1936

Lead tetraethyl plant at Baton Rouge—Monsanto absorbed Swann interests—Pontalite and Vistenex plastics—Sorbitol and mannitol offered Atlas Powder—Urea-ammonia liquid in fertilizers

1937

Synthetic glycerine process, Shell Chemical

(Continued on page 101)

VINYL ACETATE

L. WILSON GREENE

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PROCESS AND EQUIPMENT USED FOR PRODUCING VINYL ACETATE IN MODERN PLANT AT HOECHST, GERMANY

VINYL ACETATE monomer is produced in greatest volume in Germany at Hoechst a/Main, near Frankfurt. This installation is one of the most modern of the units which comprise the huge Hoechst group of plants, a very important part of the once-powerful I. G. Farbenindustrie chemical empire. Capacity of this vinyl acetate plant is rated at 12,000 metric tons yearly. During the war, construction was started on a new unit which would double this capacity, but it was never finished. The plant was not damaged by bombing or other military operations, and by November 1945, production was getting under way slowly at a rate of less than 10 percent of capacity, turning out products to meet certain Military Government requirements.

Vapor Phase Process

The catalytic vapor-phase process, originally developed by Dr. Alexander Wacker Gesellschaft fuer Elektrochemische Industrie m.b.H. for use in their own plant, was improved and employed in the Hoechst plant. It will be recalled that the original Wacker process was based on the liquid-phase conversion in the presence of a mercury catalyst; a method understood to be in use in France and Italy.

Much of the information that follows has been taken from the report of a technical intelligence team consisting of Major R. E. Richardson, J. G. Kern, R. L. Murray and R. W. Sudhoff; the latter three being civilian Chemical Warfare Service specialists. This team investigated the Hoechst plant early in May 1945. A few months later, the same plant was visited by the writer. He examined the equipment and processes in detail with one of the German engineers who had operated the plant before and during the war.

Major items of equipment and metals used in their construction are as follows: Vaporizer, heat exchanger, separator, preheater, heater, catalyzer, and blower are made of steel; condensers, mist remover, and still are constructed of stainless steel (V4A). In the first plant, aluminum was used instead of stainless steel, but the maximum life of the equipment did not exceed 18 months. It is interesting to note that the Hoechst engineers found that aluminum is satisfactory for use with pure acetic acid, but if the acid contains as much as 2 percent of anhydride, or if acetic anhydride contains 2 percent of acetic acid, serious corrosion of aluminum results.

In the first installation, an electrically heated oven was used to heat the acetylene-acetic acid mixture before it entered the catalyzer. Later, this unit was replaced by one which was heated with high-pressure steam.

The first Wacker converter or catalyzer had a solid catalyst bed with no provision for internal cooling. This resulted in a conversion rate less than 20 percent and a short catalyst life, the latter because of fusion of the catalyst resulting, undoubtedly, from the exothermic decomposition of acetylene. This decomposition is high at temperatures above 200 deg. C.

Improved catalyzers in the Hoechst plant are two steel boxes approximately 20 ft. long, 6 ft. wide and 10 ft. high, connected in parallel so that one can be cleaned while the other is in use. The catalyst is held between vertical plates made from ⅜-in. plate, spaced 1 in. apart. By means of horizontal 2-in. steel tubes through which water flows the catalyst bed is kept cool. Each catalyzer holds about 490 cu.ft. of catalyst. Gases enter the top of the catalyzer through a header, pass downward through the mass and out through a bottom header.

Catalyst

Catalyst consists of activated charcoal impregnated with a solution of zinc acetate. The dried catalyst in the form of 3 to 5-mm. granules contains 15 parts of metallic zinc to 100 parts of charcoal. Cadmium was tried instead of zinc but possessed no particular advantage. Care is taken to avoid even traces of copper because this results in the formation of cuprene. No promoters are used.

Rate of conversion can be varied from 20 to 90 percent (in the laboratory, it is possible to obtain conversion rates as high as 98 percent), but the life of the catalyst decreases with increase in rate. Experience has shown that the best economic balance is obtained at a conversion rate of 60 percent. The rate is lowered by either increasing the gas flow or decreasing the temperature. The linear velocity of gas flow through the cataliyst bed is 2.0 ft. per sec., calculated on the free space in the mass.

With greatly increased interest in production of the vinyl resins, one of the most important groups of plastics, a description of the process and equipment used by the Germans will be of value. Their experience with various stainless steels and other materials of construction as well as with catalysts adds much of interest to the chemical engineer.

One charge of catalyst has a life of about two months, during which time vinyl acetate is produced at a rate of 400 to 500 metric tons per month. At the completion of the life cycle, the catalyst is blown out of the catalyzer unit by a stream of air and thrown away.

Calcium carbide is used for generation of acetylene in conventional wet-type units. Because it is essential in vinyl acetate manufacture to remove all traces of hydrogen sulphide and phosphine from the acetylene, the gas is scrubbed first with sulphuric acid of 80 percent strength, followed by passage over a mixture of potassium dichromate and krieselguhr distributed in layers two inches deep on trays.

Purified acetylene, mixed with acetylene recycled from the process, is bubbled through acetic acid heated to 60 deg. C. The rate of flow is adjusted so that the gas leaving the vaporizer carried with it about 23 percent by weight of acetic acid. The gas travels through a heat exchanger where it picks up heat from the vapor leaving the converter. It flows to a preheater (steam) and then into a high-pressure steam heater where the temperature of acetylene-acetic acid mixture is raised to 170 deg. C. From the heater, the gas flows into the catalyzer.

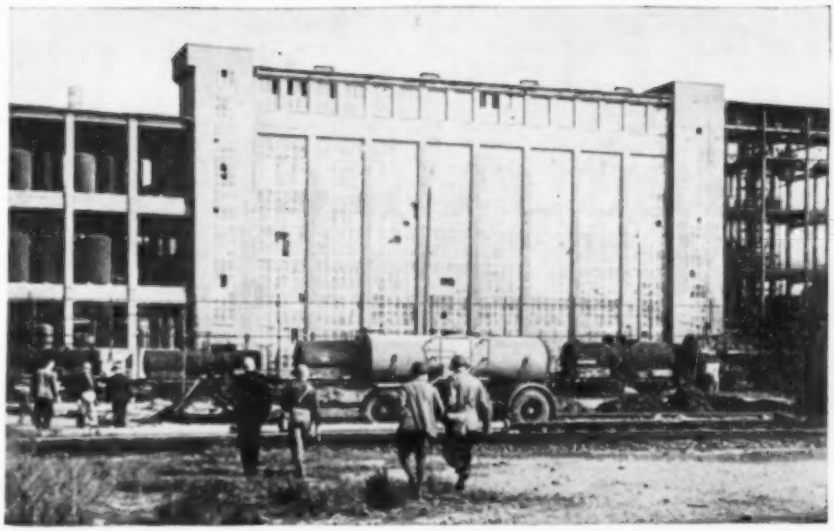
When the catalyst is fresh, the gas temperature is held at 170 deg. C., but as the life cycle of the catalyst approaches completion, the temperature is raised slowly to 210 deg. C.

The crude vinyl acetate vapor emerging from the catalyzer passes through the heat exchanger and then to a separator where carbon dust is removed. From this unit, the vapor enters a series of three condensers, the first of which is cooled with water at 40 deg. C., the second with cold water at 10 deg. C., and the third with brine at 0 deg. C. Condensate from each of these three units, plus the liquid from the entrainment separator or mist remover, collects in a common line which flows to the still.

This condensate, which may be termed crude vinyl acetate, averages 60 percent of pure vinyl acetate and 40 percent of acetic acid. The flowsheet shows a still with a single column, but actually three columns are used in the plant and the distillation process is continuous. The low-boiling fraction is mainly a mixture of acetaldehyde and acetone, next is the vinyl acetate monomer, and finally acetic acid is recovered for return to process.

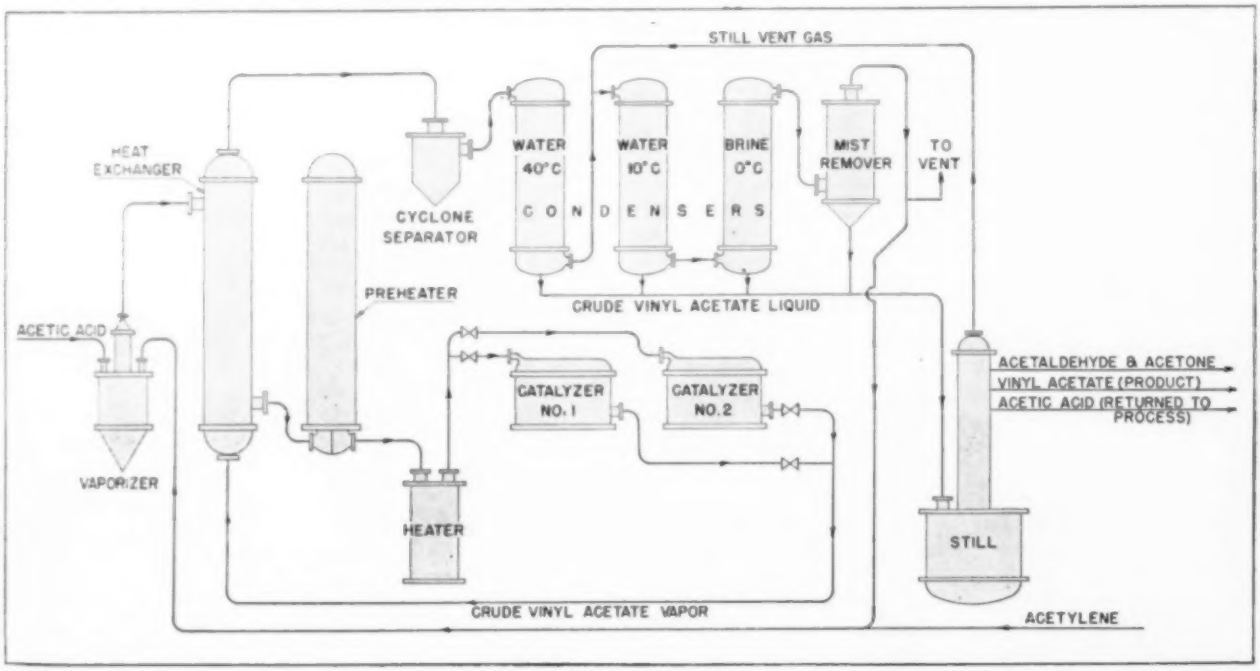
Resin formation during the distilling process is prevented by the addition of thiodiphenylamine to the crude vinyl acetate in the still. Because of this, it was found that the addition of stabilizer to the product in storage was unnecessary.

The yield of vinyl acetate varies from 92 to 95 percent based on acetylene, and 97 to 99 percent based on acetic acid. A process flowsheet of method used for production of monomer is shown. Jerry Luber, of the Plants Division, Technical Command, assisted in preparing it.



Acetaldehyde was converted into acetic acid in this building at Hoechst

Flowsheet showing method used for production of vinyl acetate monomer



Limestone Used to Neutralize Acid Wastes

A. L. REIDL

Plant Engineer, General Electric Co., Philadelphia, Pa.

A SERIES OF LIMESTONE BEDS ARE USED TO NEUTRALIZE WASTE FROM ACID DIPPING AND PLATING OPERATIONS

Many chemical engineers are interested in neutralizing acid wastes. A Philadelphia plant is using a unique system of upflow limestone beds and aeration that lowers costs and reduces maintenance. It effectively prepares the effluent for dumping into city sewers, and eliminates the need for expensive acid pumps. This article gives some interesting experimental data regarding the proper size of the beds and the optimum rate of flow of the acid.

UPFLOW beds of limestone, combined with an aeration system, have proved to be an effective means of neutralizing the acid-reacting effluent resulting from acid dipping and plating operations at General Electric's Philadelphia Works.

The installation has also proved an important economy factor, because water neutralized from the effluent will be used over and over again; first, in lifting the acid from the diluting tank by means of an eductor to the limestone beds, thus eliminating expensive acid pumps, and also to dilute the acid going through the limestone bed to assure acid concentration being held to the minimum requirements, for best operation. The neutralized effluent matter is discharged through city sewers into the Schuylkill River.

Limestone beds are advantageous for the treatment of acid reacting effluent because they are simple to construct and require little maintenance. To avoid their being made ineffective by deposits of calcium sulphate on the limestone, formation of slime, sludge, or oil accumulation in the beds, etc., they must, of necessity, be large in area and volume in relation to the quantity of effluent discharged. This assures complete neutralization of the mineral acids.

Acid Consumption

Under the present rate of production, the Philadelphia Works uses about 60,000 gal. of acid annually, consisting of approximately 15,000 gal. of muriatic acid, 24,000 gal. of nitric acid, 20,000 gal. of sulphuric acid, and 1,000 gal. of miscellaneous acids. About 30 to 40,000 gal. of water are used annually for washing.

The acid contents of the effluent in the normal procedure of acid dipping and plating operation has a pH value of approximately 3.9 to 4.4. During periods when the spent acids are being dumped, the pH value may go as low as 1.9 or even less, if too many containers are emptied at the same time.

All acid dipping, washing, and rinsing activities are manifolded into one discharge pipe, and the average flow of effluent is estimated at approximately 200 g.p.m.

Various test samples taken of this effluent showed a wide variation of acid content during a day's operation. It could be averaged as follows:

Floating material (grease, oil, etc.)	50 to 500 p.p.m.
Sediment (black, blue, or white)	600 to 2,500 p.p.m.
Acidity pH	1.9 to 4.4

Experiments* carried on for about two months during the last part of 1945 substantiated the above contentions relative to rate of flow, dilution, and size of bed needed.

For experimental purposes a two-compartment box was built. The first compartment received the effluent as it came from the plating building, plus the necessary water required for proper dilution. The second compartment contained the limestone bed, supported by a layer of large trap rock. The mixture of effluent and water flowed through an opening on the bottom of the dividing partition, through the trap rock and limestone bed, and over a weir to the sewer.

From the experiments it was readily established that, to keep the limestone bed clear of slime, sludge, etc., a rate of flow between 40 and 50 g.p.m. per sq. ft. is necessary to keep an 18 to 24-inch-deep limestone bed clear of deposits and expanded sufficiently to allow free egress of carbon dioxide gas, calcium sulphate, etc. Faster flow had a tendency to channel the bed and wash out the limestone.

Periodic checks on pH values were made to determine the effectiveness of the bed and the necessary dilution required with the acid waste to bring the final discharge to the required pH value of not less than 5.

Acid waste going into the bed, with a minimum pH value of 3, was easily brought up to pH 5. Values lower than 3 on the incoming side of the bed had a tendency to cover the limestone with calcium sulphate. To retain the highest pH values obtainable, it was essential that the effluent was diluted with from 1 to 2 parts of water, using neutralized effluent before going to sewer.

Any neutralized effluent of pH value 5 could be brought to pH 6 by agitation for a few minutes, thus liberating carbon dioxide gas contained in the water.

In an 8-hr. period, with the effluent

* Based on extensive information and data, described by Harry W. Gehm, Assoc. Dept. Water and Sewage Research, in *Sewage Works Journal*, January 1944, pp 104-120.

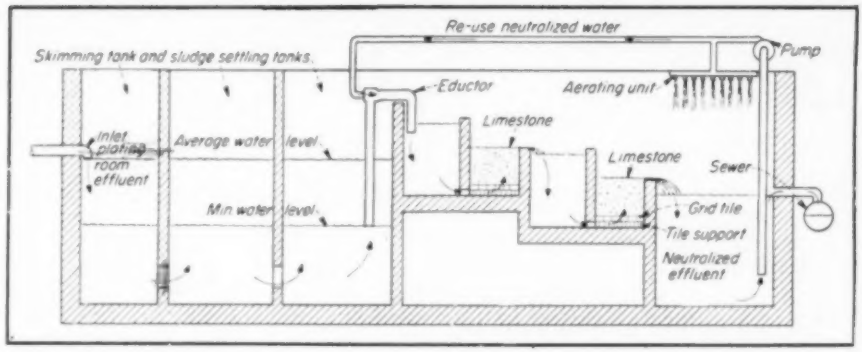
discharging from the plating room at a rate of 200 g.p.m and containing approximately 150 to 200 gal. of acid waste, the limestone consumption averaged between 5 and 10 cu. ft. The limestone crystals used in the beds vary in size between 2 and 3 mm. and have proved to be the least expensive medium for neutralizing. For best results the bed should be so constructed as to give equal pressure and flow over the entire area without channeling.

Ultimate style and design of this type arrangement, of course, depends entirely upon available space and depth of sewer arrangements, and in cases where gravity fall can be used, would prove the most economical. At Philadelphia, because of the shallowness of the sewer, lifting was necessary to provide the head required for gravity flow through the beds to the sewer.

Cheaper to Pump

It is safer and less expensive to pump the final neutralized effluent, instead of the high acid-content liquid, and consequently, provision was made to re-use the neutralized effluent in connection with an eductor to raise the acid effluent to a level high enough to provide gravity flow through the limestone beds. This scheme assures uniform flow at uniform pressure and has the additional advantage that all the re-used water for the operation of the eductor will aid in the dilution of the effluent at a 1 to 2 ratio.

The system is designed to process approximately 200 g.p.m. of plating room effluent. The pump has a capacity of 600 g.p.m., 400 gal. being used with the eductor lifting 200 gal.



How plating room effluent is treated before it is passed into city sewer

of acid waste water, and the remaining 200 gal. being pumped through the aerating nozzles. This agitation results in the loss of carbon dioxide, which should raise the pH value to 6.0 or better before flowing into the sewer.

A large concrete diluting and storage tank, divided into three separate chambers, receives the effluent from the plating building. The first chamber will act as accumulator for all oil, grease, and floating matter, and the second chamber will be accumulating all sludge and foreign material heavier than water. The suction line for the eductor is in the last chamber. The tank must be big enough to assure storage of sufficient diluted liquid so that the concentration will not be exceeded when large quantities of spent acids are dumped, in concentrated form, during the day's operation. From this tank the effluent is syphoned into the neutralizing sections by means of an eductor operated by water pressure, re-using the neutralized water. Through an opening in the bottom of the separating wall, this mixture of water and effluent flows in an upward stream through the limestone bed, into the second compartment, and from there to the last compartment. The overflow of this compartment is connected to the sewer.

Better neutralization of the effluent is assured by having two limestone beds in series. If the first bed is not high enough, due to excessive use, or if it becomes channeled, any residual acidity would be neutralized in the second bed. Also, by having double the amount of limestone area available, the need for attention is reduced.

The large tank for neutralized effluent is necessary to assure a sufficient quantity of water available for pumping and also to provide enough surface for aerating purposes.

Sufficient dilution of the effluent is necessary to keep the beds in working condition, since pH values lower than 3 aid in forming calcium sulphate on the limestone and prevent its chemical reaction.

The final discharge of effluent from the neutralizing bed should flow into an aerating unit, or some form of agitation, to drive out carbon dioxide gas which brings the pH value up to 5 or 6 or better.

AMERICAN CHEMICAL PROGRESS

(Continued from page 97)

1938

Nylon (du Pont), cellulose triacetate (Eastman), and Vinyon (Carbide & Carbon) yarns on the market—Polyvinyl butyral, Shawinigan Resins—Sulphanilamide introduced—Vanillin from wood pulp wastes, Marathon Paper Co.

1939

Houdry oil refining process—Synthetic salt cake, Mathieson Alkali

1940

Acrylonitrile and thiourea produced, American Cyanamid—Fumaric acid by fermentation, Pfizer—Gulf coast chemical development forecast—Ion exchange resins, Resinous Products—Nitro-paraffins produced, Commercial Solvents—Sodium chlorite offered, Mathieson—Uranium-235 isolated, General Electric

1941

Explosive rivets, du Pont; iron carbonyl, General Aniline and Film; magnesium from sea-water, Dow; sulfoguanadine, American Cyanamid—Rubber shortage acute

1942

Atomic Age arrived—Fluid catalytic cracking, Standard Oil Development Co.

1943

D.D.T. introduced, Ciba—Penicillin in commercial production—Silicones assumed practical importance—Synthetic rubber production begun in first large plant.

1944

Jefferson Chemical Co. organized—Quinine synthesized—Sulfhalidine introduced

1945

Folic acid synthesized, American Cyanamid—Synthetic Lube Oils, Carbide and Carbon

1946

Atomic Energy Commission established and industrial concerns undertook long-range development—Fischer-Tropsch development planned—Penicillin synthesized, du Vigneaud; crystalline penicillin produced, Heyden Chemical; crystalline sodium penicillin offered, Commercial Solvents—Streptomycin in commercial production

1947

Manufacturing Chemists' Association celebrates Diamond Jubilee

Estimating Mineral Wool Insulation

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INSULATION ESTIMATING IS NOT WELL ADAPTED TO SHORT-CUT CALCULATIONS. THIS ARTICLE PERMITS MAKING DETAILED ESTIMATES

PROCESS EQUIPMENT COSTS

This is the second of a group of articles on the estimation of heat insulation costs, prepared by Mr. Otto. The first, dealing with cork insulation for cold lines and equipment, appeared in our May issue. Remaining articles, which will be concerned with other higher temperature insulations, will appear frequently, the next in an early issue.

MINERAL WOOL insulating materials, for hot piping and other equipment, has a high rating from the standpoint of light weight and high thermal efficiency. One of the principal reasons why mineral wool insulations are not employed as much as magnesia and asbestos insulation is the fact that pipe coverers quite frequently complain of real or imagined silicosis and dermatitis. It cannot be denied that even when handling samples of mineral wool products tiny fibers quite often penetrate the skin of the hands of the person handling such samples. However, the use of a skin protecting antiseptic ointment over hands and arms, and other common safety measures, will enable a mechanic to install mineral wool pipe covering, blankets, blocks and cement just as quickly and efficiently as he would install other standardized insulation materials.

Mineral Wool Blankets

Mineral wool blankets are used for flat or slightly curved surfaces of larger types of heated industrial equipment. The blankets consist of heat-resisting selected mineral wool, carefully felted and treated and secured between layers of metal fabrics of a large variety as listed in Table V. Blankets are widely used for heat exchangers, stills, tank cars, towers, boilers and breeches, kilns, ducts, tanks, vessels, ovens, washing machines, furnaces, vulcanizers and many other pieces of industrial equipment. Owing to its low thermal conductivity, blanket insulation is highly efficient; the efficiency can be increased by providing an air space within the insulation by using blankets with ribs turned out against the hot surface.

Estimators should be warned to investigate the type of blankets offered for specific insulation jobs. Not all mineral wool products possess the same chemical and physical characteristics. Mineral wool, also called slag wool, rock wool, etc., is made from a great variety of raw materials, among them lead slag, iron slag, limestone, basaltic lavas, copper slag and slags from other metal production. Lead slag wool usually receives preference because of certain valuable characteristics not found in other mineral wools. A lead slag containing 30 to 50 percent calcium oxide or combined calcium and magnesium oxide will yield a good mineral wool. Slags of other compositions need added ingredients for decreasing brittleness of the fiber and attaining springiness and chemical resistance. Where large quantities are involved the estimator should secure copies of the U. S. Government specifications for mineral wool blankets and should make certain that the offered mineral wool meets the tests for resistance to vibration, thickness of fibers, shot content, water repellency, and alkalinity.

Because mineral wool blankets are supplied in sizes of 2 x 4 ft. and 2 x 8 ft. the application can be done with less labor in shorter time than would be possible with most other insulation materials. The area which can be covered at one time is more than five times greater than standard sizes of other prefabricated branded insulations. The thicknesses for best results have been listed in Table III, from which the estimator will note that blankets are furnished in thicknesses up to 8 in. Many operators, however,

Table I—Thermal Conductivity of Mineral Wool Insulation

Mean Temperature, Deg. F.	*k* Factor, B.t.u./Hr., Sq. Ft., Deg. F. per In. — Density, Lb. per Cu. Ft.				
	6	8	10	12	Usual *
50	0.220	0.232	0.215	0.262	0.252
100	0.270	0.273	0.255	0.290	0.286
150	0.320	0.315	0.297	0.320	0.322
200	0.380	0.357	0.342	0.355	0.357
250	0.430	0.400	0.383	0.385	0.392
300	0.480	0.442	0.425	0.418	0.428
350	0.540	0.485	0.467	0.447	0.464
400	0.590	0.527	0.511	0.478	0.500
450	0.650	0.570	0.552	0.508	0.535
500	0.700	0.618	0.598	0.537	0.571
550	0.750	0.655	0.642	0.562	0.605
600	0.810	0.697	0.682	0.602	0.642
650	0.860	0.742	0.725	0.637	0.677
700	0.910	0.787	0.769	0.667	0.712
800	.....	.....	.....	.....	0.750
900	.....	.....	.....	.....	0.810
1,000	.....	.....	.....	.....	0.900
1,100	.....	.....	.....	.....	1.000
1,200	.....	.....	.....	.....	1.100

* *Note:* The *k* factors listed under "Usual" represent maximum figures quoted by manufacturers of mineral wool insulations for their respective products, i.e. blankets, pipe coverings and loose mineral wool.

prefer to build heavy insulations up to the required thicknesses by using high temperature cement as a base and blankets of 4-in. thickness to make up the total required thickness.

The list prices for blanket insulation have been given in Table VI and the discounts are listed in Table XI. If the estimator has to calculate the job by material and labor, he should take the net cost of the blankets plus freight and hauling, the cost of the high temperature cement for undercoat, if required, the cost of the cement finish coat, and finally the cost of the weatherproofing coat, if it is an outside job. In addition, he must estimate the cost of erection of the scaffolding, the tackwelding of angle iron and cold rolled steel rings for supports of the blankets, and the actual labor cost for applying the blankets as well as the coatings. However, all these costs for the complete application job have been estimated and are listed in Table XII. The estimator therefore need only add together the net price of the type of blanket chosen and the square-foot prices for application as listed in Table XII to arrive at the total cost of the installation.

Table II—Thermal Conductivity of High Temperature Mineral Wool Blocks

Mean Temperature, Deg. F.	Brand *A*	Brand *B*
200	0.36	0.41
400	0.41	0.45
600	0.48	0.60
800	0.56	0.75
1,000	0.64	0.90
1,200	0.73	1.10
1,400	0.81	1.20
1,600	0.91	1.50

Table III—Guide for Thickness* of Mineral Wool Blanket Insulation

Operating Temperature, Deg. F.	Thickness of Blanket, In.	Thickness † of Base Coat, In.
100 to 200	1	..
201 to 300	1½	..
301 to 500	2	..
501 to 700	2½	..
701 to 900	3	..
901 to 1,100	3½	..
1,101 to 1,200	4	..
1,201 to 1,400	4	1
1,401 to 1,600	4	2
1,601 to 1,800	4	3

* To the above thicknesses add a ½-in. coat of mineral wool cement and for outside installations, an additional ¼-in. coat of weathersealing compound on top of the cement finish.

† Consists of mineral wool nodules, asbestos fiber and colloidal clay.

Pipe Covering

Like the blanket type mineral wool insulation, mineral wool pipe covering is also made from high temperature-resisting and moisture-repellent, long-fiber, specially selected mineral wool and the general specifications applying to blankets readily apply to pipe covering, since both are made from the same raw materials. Pipe covering is shipped flat and is fitted around the pipe for easy application. Mineral wool pipe covering actually is a small blanket, armored on the inside and the outside with expanded metal. The covering is held on the pipe by lacing the edges of the metal fabric together by means of No. 18 B.w.g. copper wire. The outside armor is usually full-fashioned copper-bearing expanded metal, whereas on the inside, against the hot surface, strips of the same material are used. Mineral wool pipe covering is made in 2-ft. long sections; for small and medium diameter pipes one section goes around the pipe completely, whereas for large diameter pipes two or more segments may be required. These sections and segments are also available for circular equipment and pipes having diameters larger than 30 in. Upon request this blanket type pipe insulation may be furnished in rectangular sections of 12 or 24 in. width and 24 or 36 in. length, both sides reinforced with galvanized wire netting of a wire thickness of 0.035 in., and both layers of wire netting fastened to each other through the blanket itself by wire spaced not more than 8 in. centers.

Table V—Type Numbers and Identification of Mineral Wool Blankets

Type No	Construction Details* One Side	Other Side
1	W. M.	W. M.
2	W. M.	S. L.
3	W. M.	E. M.
4	W. M.	½ in. R. L.
5	W. M.	½ in. R. L. (rib outside)
6	W. M.	¾ in. R. L.
7	W. M.	¾ in. R. L. (rib outside)
8	W. M.	M. L.
9	S. L.	S. L.
10	S. L.	E. M.
11	S. L.	½ in. R. L.
12	S. L.	½ in. R. L. (rib outside)
13	S. L.	¾ in. R. L.
14	S. L.	¾ in. R. L. (rib outside)
15	F. S.	F. S.
16	½ in. R. L.	½ in. R. L.
17	M. L.	M. L.
18	M. L.	½ in. R. L.
19	M. L.	½ in. R. L. (rib outside)
20	M. L.	¾ in. R. L.
21	M. L.	¾ in. R. L. (rib outside)
22	E. M.	E. M.
23	A. P.	A. P.

* *Key:* W. M., 1 in. galv. wire mesh; S. L., stucco lath; F. S., No. 12 mesh fly screen; R. L., rib lath; M. L., copper-bearing metal lath; E. M., expanded metal lath; A. P., asbestos paper.

Table IV—Guide for Thickness of Mineral Wool Pipe Covering*

Temperature, Deg. F.	Pipe Diameter, Inches: 2 to 3½ — Insulation Thickness,† Inches			4 to 4½ — Insulation Thickness,† Inches			5 and up — Insulation Thickness,† Inches		
	I	O	U	I	O	U	I	O	U
Below 212	1	1½	1	1	1½	1	1	1½	1
212 to 267	1	1½	1	1	1½	1	1	1½	1
268 to 338	1	1½	1	1	1½	1	1	1½	1
339 to 388	1	1½	1	1	1½	1	1½	2	1
389 to 500	1	1½	1	1½	2	1	1½	2	1
501 to 600	1½	2	1	1½	2	1	2	2½	1½
601 to 700	1½	2	1	2	2½	1½	2	2½	1½
701 to 800	2	2½	1½	2	2½	1½	2½	3	2
801 to 1,000	2	2½	1½	2½	3	2	3	3½	2½

* *Note:* Mineral wool pipe covering is not manufactured in thicknesses below 1 in. and not for pipes having a diameter of less than 2 in.

† *Key:* "I" stands for inside piping, "O" stands for outside piping, "U" stands for underground piping.

In estimating pipe covering costs the engineer has to consider the cost of the material itself, the heat saving efficiency, the life of the insulation, and the cost of application. The heat saving efficiency is a result of the thermal coefficient, and in the case of mineral wool insulation the *k* factor is closely related to the density of the material. Table I lists the thermal coefficients of mineral wool products of various densities and gives also the average *k* factors of several standardized, branded mineral wool insulations. U. S. Government specifications call for a maximum density of 12 lb. per cu. ft., including the weight of armor in the case of blankets and pipe covering. As long as the estimator can get a guarantee of the density of the material to be offered he will be able, with the help of Table I, to determine the thermal conductivity and, therefore, the efficiency of the insulation he proposes to use for a certain job.

The list prices for mineral wool pipe covering are listed in Table VII and the discounts to the industrial buyer are given in Table XI. As in the case of mineral wool blankets the prices for mineral wool pipe covering are f.o.b. manufacturers' shipping points; the freight and hauling

Table VI—List Prices for Mineral Wool Blanket Insulation

(Basis, dollars per square ft.)

Thickness, Inches	Type Numbers: 1	2, 3, 8	9, 17, 10, 22	11, 5, 12, 18, 4, 19	13, 7, 14, 6	16, 20, 21	15	23
1	0.40	0.45	0.55	0.60	0.70	0.75	0.60	0.65
1¼	0.45	0.53	0.60	0.65	0.75	0.83	0.65	0.70
1½	0.50	0.60	0.65	0.70	0.80	0.90	0.70	0.75
1¾	0.55	0.65	0.70	0.75	0.85	0.95	0.75	0.80
2	0.60	0.70	0.75	0.80	0.90	1.00	0.80	0.85
2½	0.70	0.80	0.85	0.90	1.00	1.10	....	....
3	0.80	0.90	0.95	1.00	1.10	1.20	....	....
3½	0.88	0.98	1.03	1.08	1.18	1.28	....	....
4	0.95	1.05	1.10	1.15	1.25	1.35	....	....
4½	1.03	1.13	1.18	1.23	1.35	1.45	....	....
5	1.10	1.20	1.25	1.30	1.45	1.55	....	....
5½	1.18	1.28	1.33	1.38	1.55	1.65	....	....
6	1.25	1.35	1.40	1.45	1.65	1.75	....	....
6½	1.35	1.43	1.48	1.53	1.75	1.85	....	....
7	1.40	1.50	1.55	1.60	1.85	1.95	....	....
7½	1.48	1.58	1.63	1.68	1.95	2.05	....	....
8	1.55	1.65	1.65	1.75	2.05	2.15	....	....

Table VII—List Prices for Mineral Wool Pipe Covering

(Basis, dollars per lineal foot)

Pipe Sizes,* Inches	Wall Thickness of Covering, Inches: 1	1½	2	2½	3	4
2	0.70	0.90	1.30	1.65	2.20	3.10
2½	0.75	1.00	1.40	1.75	2.30	3.25
3	0.85	1.10	1.50	1.85	2.45	3.40
3½	0.95	1.20	1.60	1.95	2.60	3.55
4	1.05	1.30	1.70	2.05	2.75	3.70
4½	1.15	1.40	1.85	2.20	2.90	3.85
5	1.25	1.50	2.00	2.35	3.05	4.00
6	1.35	1.65	2.15	2.50	3.30	4.20
7	1.50	1.80	2.30	2.70	3.55	4.50
8	1.65	1.95	2.50	2.95	3.80	4.80
9	1.80	2.15	2.75	3.20	4.10	5.10
10	2.00	2.35	3.00	3.50	4.40	5.50
12	2.20	2.70	3.30	3.80	4.80	6.00
14	2.50	3.00	3.60	4.20	5.30	6.50
16	2.80	3.30	4.00	4.60	5.80	7.10
18	3.10	3.60	4.40	5.00	6.30	7.60
20	3.40	3.90	4.80	5.50	6.90	8.20
24	4.00	4.60	5.60	6.40	7.90	9.50
30	5.00	5.60	6.80	7.80	9.40	11.20

* Sizes 2 to 12 in. are nominal; 14 in. and larger are O. D.

Table VIII—List Prices for Mineral Wool High Temperature Blocks

(Basis, dollars per sq. ft., f.o.b. shipping points)

Thickness, Inches	List Price	Thickness, Inches	List Price
½	$0.27	2¼	$0.68
¾	0.27	2½	0.75
1	0.30	2¾	0.83
1¼	0.38	3	0.90
1½	0.45	3¼	0.98
1¾	0.53	3½	1.05
2	0.60	4	1.20

Table IX—List Prices* for Mineral Wool Insulating Cement

(Basis, dollars per 50-lb. bag)

Quantity	National Buyer	Average Buyer
C. L. lots	$3.00	$3.15
40 Bags and over, but less than C. L. L.	3.30	3.50
39 Bags and less	3.55	3.75

* *Note:* Full freight allowance to buyer's destination for C. L. L. For less than car load lots full freight allowance up to $1.25 per 100 lb. freight rate.

Table X—List Prices* of Loose and Granulated Mineral Wool

(Basis, dollars per ton)

	C. L. L.	L. C. L.
Loose mineral wool	$52.00	$58.00
Granulated mineral wool	71.00	76.50

* *Note:* Full freight allowance up to $0.80 per 100 lb. on C. L. L. and up to $1.25 per 100 lb. on L. C. L. The minimum car load quantity is 24,000 lb.

charges, therefore, must be added. The estimator will find that the list prices and discounts quoted by a number of manufacturers are identical. He, therefore, must make his choice on the differences in chemical and physical properties. Besides other requirements mentioned before (see Blankets) the material to be selected by the estimator shall have not more than 20 percent by weight of shot, which are small glassy pellets and beads without recognizable insulating properties; the sulphur content must be below 0.5 percent; the sodium oxide content must be below 0.25 percent, and in the heat test the material must be subjected for 6 hr. to 1,000 deg. F. without showing signs of fusion, shrinkage or detrimental changes.

Mineral wool pipe covering is suitable for all heated pipes up to 1,000 deg. F. and is especially well adapted for buried pipes, for piping in trenches, channels, tunnels, and wherever pipes are so close to the ground, wall or ceiling (or to neighboring pipes) that the installation of premolded sectional pipe covering, made from other standardized insulating materials, presents difficulties. The small rectangular mineral wool sections can easily be slipped around a pipe and the two ends are clamped together on the accessible side by means of hog rings or laced together with flexible wire. It is only necessary to have enough clearance for the thickness of the blanket pipe covering itself. The thicknesses recommended for efficient heat saving under various conditions have been listed in Table IV. If the installation can be kept dry it is not necessary to cover the mineral wool, except when a neat appearance is required, in which case a coat of ¼-in. mineral wool cement or asbestos cement may be applied. Or, instead of the cement finish, a layer of 45- or 65-lb. roofing felt may be installed. For greater heat savings economy, either a cement coating or roofing felt may be laid over the pipe covering. For outdoor jobs it is recommended to cover the insulation with roofing felt or galvanized sheet metal.

The cost of applied mineral wool pipe covering is the aggregate of the pipe covering itself, freight, hauling, lacing wire, cement coat, roofing paper, scaffolding, and labor. In order to arrive at the total cost of mineral wool pipe covering the estimator should determine the net delivered cost of the pipe covering itself and should add the cost of installation as listed in Table XIII. It will be noted that only three thicknesses have been listed; application costs for other thicknesses should be approximated. The cost for application is based on $2 per hour for labor and cost prices for cement, canvas and roofing felt, wire, twine, etc., are those prevailing in June 1947.

Blocks and Boards

Wherever flat surfaces of heated equipment have to be insulated against heat losses, the designing engineer will find that certain mineral wool insulating blocks possess characteristics which make the use of mineral wool desirable. These blocks are effective over the entire temperature range up to 1,600 deg. F., and in the case of products of a few manufacturers, up to 1,700 deg. F., in contrast with most other standardized insulating blocks which are made for either high or normal temperatures, not both. The *k* factors for these blocks

are lower than those listed in Table I, as may be seen by comparing the figures in this table with those in Table II. The density of these blocks is usually 18 lb. per cu. ft., which is light in weight for high temperature insulating material.

As a rule these blocks are widely used for breechings, behind furnace refractories, for lehrs, ovens, boiler walls, annealing pits, hot air ducts, heat treating furnaces, kilns in glass and ceramic industries, chilling pits, pit covers, turbines, and tanks and towers in refineries. The thicknesses to be applied correspond with those given in Table III but no undercoat is required for higher temperatures. The maximum thickness of these blocks is 4 in.; a 6-in. thick insulation, therefore, consists either of two layers of 3 in. each, or one layer of 4 in. and a second layer of 2-in. thickness. For sizes and thicknesses of high temperature mineral wool insulation blocks see Table XIV.

For high temperature operations thermal expansion and contraction factors are of prime importance. These blocks, when subjected to a temperature of 1,200 deg. F. in a muffle furnace, showed only 0.03 percent shrinkage and at 1,740 deg. F. the shrinkage was only 0.84 percent. After being immersed in water for 72 hours the weight of sample pieces increased only 22 percent. When manufactured by reputable companies, such blocks are inert and chemically neutral, the pH value usually lying between 6.8 and 7.2. Their application is commonly done in the same manner as with magnesia blocks, asbestos blocks and other standardized insulating materials for the same purpose. However, high temperature mineral wool blocks may also be applied by means of hot asphalt; the blocks will not be affected when dipped in hot asphalt of 450 deg. F., picking up approximately 0.18 lb. asphalt per square foot of surface.

List prices are quoted in Table VIII and the respective discounts from the list prices are scheduled in Table XI. When estimating the cost of application the engineer has to consider the cost of the block itself plus freight and hauling charges in addition to the cost of the sundries used in the installation work and the labor cost. The sundries vary with the type of finish desired. For inside installation a ½-in. coat of insulating cement, and a good paint coat, is usually sufficient. Where damage to the insulation by labor, dripping water, or steam can be expected, 8-oz. canvas should be applied over the cement coat. For outside installations a layer of 65-lb. roofing felt or galvanized sheet metal should be applied. In all cases the cost of wire, bands, supports, twine, canvas, roofing felt, etc., has to be included in the calculation. The cost of labor depends on many factors, for instance the height of the equipment, the cost of erecting scaffolding, whether vertical or horizontal equipment has to be covered and, finally, what type of men will be on the job. For estimating purpose it will be close enough if the cost figures given in Table XII (applying to mineral wool blankets) are used for high temperature mineral wool insulation blocks and boards.

Table XI—Discounts From List Prices for Mineral Wool Insulations

Product	Discount, Percent—C. L. Lots	L.C.L. Lots
Mineral wool blankets	65	63
Mineral wool pipe covering	65	63
High temperature blocks		
(a) National buyers *		
Zone 1	45	43
Zone 2	42	32
Zone 3	43	33
(b) Average buyer *		
Zone 1	41	37
Zone 2	35	24
Zone 3	36	25
Mineral wool insulating cement	0	0
Loose mineral wool	0	0
Granulated mineral wool	0	0

* *Note:* Zone 3 comprises certain counties in Colorado, Texas, California, Nevada, Oregon, Washington, Wyoming; Zone 2 comprises most of the rest of the counties in Colorado, Nevada, Oregon, Texas, Washington; Zone 1 comprises practically all the rest of the United States.

Table XII—Cost of Installing Mineral Wool Blankets *

(Basis, dollars per sq. ft.)

Thickness, Inches	Installation Height—Below 15 ft.	15 to 25 ft.	Above 25 ft.
1	$0.75	$0.85	$0.92
1¼	0.80	0.90	0.98
1½	0.85	1.00	1.09
1¾	0.90	1.06	1.14
2	0.95	1.12	1.19
2½	1.00	1.18	1.26
3	1.05	1.25	1.35
3½	1.10	1.30	1.40
4	1.15	1.35	1.46
4½	1.25	1.45	1.59
5	1.30	1.60	1.70
5½	1.35	1.65	1.78
6	1.40	1.70	1.84
6½	1.45	1.75	1.89
7	1.50	1.80	1.95
7½	1.55	1.85	2.05
8	1.60	1.95	2.15

* Based on $2 per hour labor cost. Deduct 10 percent for inside jobs without weatherproofing.

Table XIII—Cost of Installing Mineral Wool Pipe Covering *

(Basis, dollars per lin. ft.)

Pipe Size, Inches	Thickness of Pipe Covering, 1 In.—No Finish	Roofing Felt Finish	Sewed Canvas Finish	½-In. Cement Finish and Roofing Felt
2	$0.25	$0.45	$0.75	$0.65
2½	0.30	0.50	0.80	0.70
3	0.35	0.55	0.87	0.75
3½	0.40	0.60	0.93	0.80
4	0.50	0.70	1.04	0.90
5	0.60	0.80	1.16	1.05
6	0.75	0.95	1.32	1.22

* Add 10 cents per lin. ft. for 1½-in. thickness and 15 cents per lin. ft. for 2-in. thickness.

Insulating Cement

Mineral wool in the form of plastic cement is used as a base beneath other insulating materials, as a finish coat on top of other insulation, and for the covering of valves and fittings. It may also be used for the full covering of smaller pieces of equipment, especially when the surfaces are quite irregular. However, when larger pieces are to be insulated it is usually more econom-

Table XIV—Forms, Dimensions, Packaging and References of Mineral Wool Insulations

Blankets

23 types, as listed in Table V.
Thicknesses from 1 to 8 in.
Sizes 2 x 4 or 2 x 8 ft. Special sizes upon request.
Packed in 200-lb. test cartons or crates.
Guide for selection of thicknesses, see Table III.
List prices, see Table VI.
Discounts from list prices, see Table XI.
Cost of installation, see Table XII.
Thermal conductivity, see Table I.

Pipe Covering

Thicknesses from 1 to 4 in.
Length of sections, 2 ft.
Width of sections: to cover circumference of pipes 2 to 30 in.
Packed in cartons or crates.
Guide for selection of thicknesses, see Table IV.
List prices, see Table VII.
Discounts, see Table XI.
Cost of installation, see Table XIII.
Thermal conductivity, see Table I.

High Temperature Blocks

Thicknesses from 1 to 4 in.
Sizes 6x18 in., 6 x 36 in., 12 x 18 in., 12 x 36 in.
Shipped in cartons of approx. 40 lb. as follows:
2½-in. thick blocks, 45 boardfeet per carton.
3½-in. thick blocks, 42 boardfeet per carton.
All other thicknesses, 36 boardfeet per carton.
Guide for selection of thicknesses, see Table III.
List prices, see Table VIII.
Discounts, see Table XI.
Cost of installation, see Table XII.
Thermal conductivity, see Table II.

Plastic Cement

Packed in bags of 50, 40, 35 lb. (multiwall paper bags).
Thickness of insulation: ½ in. thicker than pipe covering.
List prices, see Table IX.
Discounts: none.

Loose and Granulated Fibers

Packed in multiwall paper bags of 35 and 40 lb.
List prices, see Table X.
Discounts: none.

ical to employ blankets, boards or blocks. The reason is the slowness in applying one layer after another of wet cement, the need of steam to dry out the layers, and the waiting period between the drying of each layer. This cement consists of mineral wool fiber, asbestos fiber and adhesive binders, thoroughly mixed, and is easily appliable with a trowel. Sodium chloride must be absent, sulphur content must be below 0.5 percent, shot content must be below 10 percent and the cement must not support corrosion. The thermal conductivity should be about 0.9 at a mean temperature of 200 deg. F. and 1.10 at a mean temperature of 700 deg. F. For estimating purposes the engineer can take 50 sq. ft. of 1-in. thickness for 100 lb. of cement as a safe figure. Some brands of mineral wool cement exceed this coverage minimum; if the coverage is appreciably below 50 sq. ft. then the material does not possess the same insulating value and must therefore be lower in price. The adhesive property of mineral wool cement should be not less than 3 lb. per sq. inch. A shrinkage of 20 percent is permissible, and the dried insulating cement should not weigh more than 30 lb. per cu. ft.

The list prices for this cement have been given in Table IX and as shown by Table XI there is no discount available, but freight allowance will be granted by the manufacturers.

Fiber and Granules

Mineral wool in loose and granulated form has only restricted use in the chemical industry. The insulating qualities of these two types are the same; they differ only in their physical shape. The loose wool is in long fiber form as it comes from the cupola and in this form it is well suited for filling large areas such as on ovens or furnaces. The granulated form is the loose wool reduced to nodules varying in sizes from ¼ in. to ⅜ in.; this is used for filling more confined spaces where it is not easy to pack the bulk loose wool. In the industry we find both types principally used for furnace and boiler walls, hot water tanks, expansion joints, incinerator walls, glass annealing equipment, oven walls and, in addition, as fill material around pipes in trenches and boxes.

A good mineral wool in loose and granulated form will stand 1,350 deg. F. temperature without fusion; on the other hand it must not absorb moisture, and must retain its resilience. A mineral wool which settles is of no value whatsoever. Mineral wool furnished for fill purposes usually weighs 8 lb. per cu. ft. and has a thermal conductivity of 0.26 at 70 deg. F. mean temperature difference. The *k* factors listed in Table I under 8 lb. density apply to the better grades of mineral wool. A material of this density will cover approximately 17 to 18 sq. ft. 3 in. thick per bag of 35 lb.

List prices for both types of mineral wool fill material have been given in Table X and from Table XI it will be seen that no discount is applicable. However, the manufacturers will allow certain freight rebates.

Cost of application cannot be given because the entire cost is the wages for labor and since filling of open spaces with mineral wool can hardly be called insulation work it is possible to employ common labor.

Estimating Installations of Chemical Equipment

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PROCESS EQUIPMENT COSTS

THIS ARTICLE is intended as a brief discussion of a few practical methods of cost estimating, including the necessary philosophy pertinent to good estimating. In large chemical plants, the production and maintenance engineers have the advantage of a special engineering division, where facilities are available, which usually includes mechanical and chemical engineers, estimators, project engineers, structural and design engineers, draftsmen, etc. Their files are generally very complete and contain manufacturers' catalogs, cost standards, design standards, and so on. This paper is not intended to interest such estimators.

The discussion, then, is directed toward the production chemist or plant engineer in a small or medium sized plant, who is called upon infrequently by management to prepare an estimate. Such a man has good cause to consider himself "on the spot." Few men in this category have files of manufacturer's catalogs and other information needed for proper selection of standard type equipment, and lack any facilities for estimating the cost of equipment requiring special design. If the estimator were given adequate time to consult with outside manufacturers, fabricators and engineers, he would be perfectly capable of arriving at a close and reasonable cost. However, this time is seldom to be had since management requires many weeks and sometimes months to formulate its future plans to the point of asking for an estimate. Yet, after the request for an estimate, time becomes of extreme importance. Although management has many problems to settle before it is in a position to require an estimate, it is generally agreed that estimators are not given the time required to turn out a clear and concise estimate.

There are many methods used in estimating—the most amusing one is the well known "Guesstimate" or "Quickie." It is usually accomplished by a telephone or verbal conversation in which a person requires a quick, rough cost. This method is very vulnerable, as it results in snap judgment on the part of the estimator without any thought given to the many details which may demand additional time and money at a later date. There is justification for this type of estimate if it is used to give management an indication of the financial scope of the project. However, a formal estimate should be required for appropriation purposes.

An estimate that is based on a similar previous installation can be produced satisfactorily with a minimum of thought and time, provided the estimator has a clear and concise picture of what is required and has available actual costs of previous installations.

Estimates that cover unfamiliar equipment, however, require the utmost in thought, vision, available specifications and a working knowledge of design. It is true that by contacts with manufacturers, discussion might bring forth many practical ideas which could be included in the design and perhaps a verbal estimate could be obtained. However, this procedure requires considerable time and if the design is complicated, might still require an outside consultant. Data on hook-up items which are normally included in an estimate and include pipe, fittings, valves and specialties in all materials of construction are

available in catalogs, and supply houses will readily furnish quotations.

Estimating the labor portion of this type of installation requires the ability to understand the work as performed by the various trades, which include carpenters, millwrights, electricians, pipe-fitters, welders, etc. An effective way of arriving at labor costs in accordance with local wage conditions is to use the man-day basis, and by watching various trades at work to arrive at an estimate of what each man appears to be capable of performing each day. Another variable, however, is the mechanical foreman in charge of the trade. Certain foremen, by means of personality, ability and persuasion, are able to get more work per day from their men. If this situation is known to exist, the master mechanic, plant engineer or supervisory foreman should be notified so that the situation can be corrected. It is impractical to vary labor costs to suit the individual foreman.

An accompanying tabulation shows one method of recording estimating data that has the advantage that it can be kept for future reference and checking. The items as shown do not represent actual costs. They serve only to illustrate.

In order to explain what the writer believes to be a simple and quick method of estimating, the installation of a motor pump of cast iron construction in a flammable hazardous location will serve as a typical example. If the pump costs approximately $300, including an explosion-proof Class 1, Group D motor, it will require an explosion-proof starter costing about $25 and the necessary conduit and condulets, wire, carbon steel pipe, fittings and valves will cost an additional $50. Including lumber and concrete for the pump foundation, the total becomes $100 or 33 percent of the initial cost of the pump. The labor to install this pump will require a pipefitter and helper totalling 10 man-hours; millwright, 4 man-hours; carpenter, 2 man-hours; mason, 2 man-hours; electrician and helper, 16 man-hours. Assuming the average rate including overhead at $2 per hour, the labor would total $68 or approximately 20 percent. If special materials of construction were used, such as stainless steel, Hastelloy, porcelain, hard rubber, etc., the initial cost of the pump would increase 50 to 100 percent. The pipe, fittings, valves, etc., would advance to approximately 50 percent of the pump cost and the labor would increase approximately 10 percent more than if constructed of cast iron or carbon steel, owing to the careful handling required on special materials.

The same percentages hold true on complete, small plant units. A typical example would be a vacuum distillation unit, which might involve a jacketed agitated still, and include condenser, receiver and steam jet or vacuum pump. If all the items were constructed of carbon steel and cast iron, the installation material and labor would approximate 50 to 70 percent of the total purchase cost of the equipment. If the distillation unit were constructed of glass lined carbon steel or special alloy, the material and labor would approximate 80 to 100 percent of the cost of the equipment. In a very small plant where mechanics handle more than one trade, it is possible to reduce these percentages of material and labor appreciably.

This reasoning should not be used for very expensive pieces of equipment costing thousands of dollars, which require small amounts of piping and electrical work. This type of installation requires special thought, with each detail properly priced.

Mistakes to Avoid

There are many reasons for poor estimating. However, there are some common mistakes that can be eliminated. One is the failure to understand the work being estimated. Incomplete specifications due to the lack of technical information may be a contributing factor, and the exchange of information between departments is essential.

Failure to survey service requirements, such as refrigeration, steam, water, air, vacuum, and waste disposal including sewerage, may cause improper functioning of the new installation and, also, may affect other existing operations. This error usually results in a very costly addition of equipment or revision of the plant distribution system. Additions to the installation caused by after-thoughts are a constant grievance to the estimator and can be a serious threat to the financial soundness of the company. After-thoughts of this sort are usually expensive and extend the completion date of the installation, in turn causing the new product, or the increased production of the existing product to be kept off the market and costing the company considerable profit. On many occasions failure to be fire- and safety-minded during the initial planning of the project not only results in hazard to the employees, but likewise extends the completion date of the installation.

Inability to visualize the completed installation is the cause of many additions, deletions, and revisions. In general, there is an advantage to the estimator not only in sketching a flow sheet of the equipment, but also in including a plot plan, and if time allows, a piping drawing showing considerable detail. However, in small and medium-sized chemical plants, the estimator has other important and time consuming duties and cannot take the time required. It is the writer's belief that this additional time is justified.

There is a definite psychological aspect to estimating, and if possible, it is advantageous to blend the managements' philosophy with that of the estimator, and to agree on the basic principles which include the method of estimating, the time allowed for estimating, and if possible, a pre-arranged percentage of over- and under-run. In the writer's opinion, management does not give enough consideration to the amount of time required to prepare and evaluate a formal estimate. Upon presentation of the estimate to management, there are usually individuals who are in a position to oppose the estimated costs which they unjustly criticize, in some cases rounding out the figures by deducting amounts that may represent the usual contingencies of 10 percent. A wise estimator is prepared to substantiate his costs, but must first believe in his own mind that his figures as planned are reasonable, concise and accurate to the best of his ability. Estimators are vulnerable to published inter-company reports, which indicate to their superiors any failure on their part to turn out a close estimate.

In conclusion, there are three good rules to follow:

1. Make yourself take the time to turn out a good estimate.
2. By your own effort, acquire from varied sources in and out of your own organization all pertinent information.
3. Use good, plain "horse sense" in listing every item involved on the project, which includes safety, fire and service requirements.

Typical Form for Tabulation of Estimating Data

Description	Equipment on Hand	Outside Contract	Equipment to Be Purchased	Material Purchased from Stores	or Company Labor	10 Percent Contingency	Total
50-ton refrigeration unit	None	$6,000	$18,000	$1,000	$2,000	$2,700	$29,700
C. I. motor pump	None	None	300	100	60	50	500
S. S. still	$5,000	None	None	1,200	600	680	7,500

Estimation of Instrument Costs

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EASY PRE-CONSTRUCTION ESTIMATING MEANS BECOME MORE ESSENTIAL AS INDUSTRIAL INSTRUMENTS ASSUME EVER INCREASING IMPORTANCE

PROCESS EQUIPMENT COSTS

Estimation of the cost of instruments for a given process can often be approximated for preliminary purposes as a percentage of total installed cost of process equipment, although this percentage will vary both with the process and with individual requirements. For greater accuracy, once the detailed instrument needs are known, the article gives typical costs for instruments, accessories and installation.

INSTRUMENTATION of chemical operations, especially where continuous processing is involved, has increased many fold during the past decade or two. This increased usage of instruments and automatic controls is a result of several factors all intimately associated, directly or indirectly, with processing economies. Instrumentation is responsible to a large degree not only for the economic success of many processes, but also for the practical operation of many processes. Numerous continuous processes, as, for example, ethylene and styrene producing plants, solvent dewaxing units, and catalytic crackers, would be inoperable without modern instruments and controls.

Instruments are rapidly becoming an integral consideration in the design of all processing plants and the conception that indicating, recording, and controlling instruments are accessories "to be added later" is seldom encountered where new construction is involved. Consequently, instrumentation costs now represent a significant portion of the overall investment in plant equipment, whereas, in a past era the expenditure for instrumentation was oftentimes placed in the realm of incidental costs.

It must be stressed that while most plant designers and contractors recognize the factor of instrumentation at the outset of a project, they too often relegate the proposed expenditure for instrumentation at the tail end of their project budget thinking. Consequently, instrumentation costs often are underestimated, with resultant penalties to smooth and efficient process operation. Although only 5 percent of the investment in a plant may be required for instrumentation, it is an extremely important 5 percent and, if trimmed by only ¼ percent, the "apparent" savings will ultimately be reflected in one of several ways, including higher overall costs and lower product quality.

In this article, an attempt is made to provide the process design engineer with a means for approximating the instrumentation costs of his process to the end that his budget for instrumentation will be ample. The subject is approached from two standpoints, namely, that of unit instrument costs, from which an estimate can be synthesized, and comparative costs, from which an estimate can be made by comparing the instrumentation costs of the process under consideration with the instrumentation costs of a going process of similar nature.

Unit Instrument Costs

A survey of instrumentation costs not only is complicated by the great variety of chemical processes used, the basic instrumentation requirements of which vary widely, but also by the many methods of measurement and styles of instruments available to do a given job. A process temperature can be measured in one fashion, for example, by simple, low-cost glass stem thermometers; on the other hand, where accurate, continuous, and automatic recording and controlling of temperatures are required, the instrument to do the job may logically be a self-balancing potentiometer incorporating carefully machined parts and electrical and electronic components —all mounted in a rugged case of attractive appearance for convenient mounting on a control panel. Obviously, instruments of the latter type, performing many more functions and assuming greater responsibilities, cost more. Overall instrumentation costs have risen, not only because more instruments are being used but also because the instruments themselves are more sophisticated and complex.

Tastes of the design engineer also greatly affect overall instrumentation costs. There is a trend in the design of control rooms for large processing units toward more and more attractive appearance of instrument panel boards and greater comfort and pleasing surroundings in the control room. Air conditioning, indirect lighting, soundproofing, and color dynamics in the control room are looked upon by some designers as luxury items of purely aesthetic value; other designers regard them as important contributing factors to long term operating efficiency of the unit. Some designers are content to install pressure gages on each pump or blower; other designers specify that these instruments all be incorporated on a central panel board in the pump room. The figures given in the tables with this article are based upon average installations of the day. Where centralized control is not considered essential, possibly these figures will be a trifle high; where it is desired to take advantage of centralized control and an attractive and comfortable control room, the figures will be considerably low. Thus, the factor of taste must be considered when making a cost estimate.

Process equipment costs to be of value for preliminary estimating must of necessity be expressed in round fig-

ures. In Table I the middle column lists the present average base purchase prices for several of the major types of industrial instruments. All instruments listed in this table are single-point recorders, with the exception of the strip chart potentiometer, which is for six points, since this type of instrument is most commonly used in the process industries for multiple recording. To ascertain the cost for adding pneumatic control (an average of the costs for proportional and for proportional-reset action), a factor for "Control System Components" must be added to the base instrument cost. To ascertain the cost for adding pneumatic transmission (including a pneumatic transmitter at the point of measurement and a pneumatic receiver at some remote point), a factor for "Pneumatic Transmission Components" must be added. The use of these figures will be understood best by consulting the example shown in Table II.

Accessory and Installation Costs

The first column of figures in Table I does not include two very important cost items, namely, accessories which are required to make up a complete measuring and/or controlling system, and installation cost. These costs can be added to the base instrument costs given by employing appropriate multiplying factors listed in the last two columns of Table I.

The wide variations in labor costs in various parts of the country must be taken into consideration when using the factors listed in Column (3), which are based upon prevailing costs in the Eastern seaboard.

Flow Meters—The accessories generally associated with differential type flow meters and incorporated in the factor given for flow meters include: the orifice plate, orifice flanges, shut-off valves, condensers or seals, proper connecting tubing, manifold, and mercury for the meter body. These figures are based upon an average of 4-in. and 6-in. line installations, commonly encountered in the process industries, and for pressures less than 1,000 psi. Pressures above 1,000 psi. and/or larger lines will raise equipment and installation costs proportionately. Where primary measuring elements other than orifice plates are used, the cost will be greater. A flow nozzle, for example, will cost roughly five times as much as an orifice plate, whereas a venturi will cost 10 to 20 times as much as an orifice plate.

Flow meter installation costs, in addition to other items, include: "breaking" the line to which the orifice is to be installed, installation of the orifice plate and/or flanges, installing the meter body, running connecting tubing from the line to the meter body, and mounting the instrument on a stand or on a panel in the control room. Consequently, labor costs on flow meter installations run fairly high.

Liquid Level Meters — Accessory items for liquid level meters will include: condensers or seals, connecting tubing, manifold, and mercury for the meter body. Elimination of the orifice plate and associated flanges and fittings commonly associated with a flow meter installation make the cost of liquid level accessories slightly below that of flow meter accessories.

Installation costs for liquid level meters run about the same as for flow meters and include such items as: tapping the process vessel and making it ready for installation of the connecting tubing, running the connecting tubing, mounting the meter body on a proper foundation, etc.

Pressure Gages—The major accessory items include a connecting nipple, a shut-off valve, and connecting tubing between the pressure tap and the gage proper.

Installation costs for pressure gages include drilling and tapping the pipe or vessel to which the pressure connection is to be made, and running the connecting tubing between the pressure tap and the meter proper. In general, the installation of the pressure gage as compared to the flow or liquid level meter is much simpler and generally costs are less.

Thermometers—Accessory items for thermometers include a well in which to install the thermometer, and capillary armored tubing. The cost of armored capillary tubing, which can be a large part of a thermometer installation, varies widely with the type of instrument and compensation required. The installation of a thermometer is quite similar to that of a pressure gage.

Potentiometer Pyrometers — Accessory items for potentiometer pyrometers will include a thermocouple and its protecting tube, extension or lead wire to connect the thermocouple with the instrument, conduit in which to place the extension wire.

Installation costs for potentiometer pyrometers include: tapping the process vessel, furnace, etc., for installation of a thermocouple and its protecting tube; running the extension wire in conduit; and making back-of-panel connections to the instrument. Obviously, installation costs will multiply rapidly where more than one thermocouple is connected to any given instrument. The costs shown in Table I are based upon six thermocouples per instrument. In the case of strip chart potentiometers, however, the number of points per instrument may vary from 1 to 16.

For use in making pre-construction instrumentation cost estimates at a stage before the complete instrument and automatic control layout is known, the percentage of total equipment cost

(*Continued on page 122*)

Table I—Base Costs of Typical Instruments, with Percentages to Be Added for Accessories and Installation

Instrument Types	Base Instrument Cost	Added Percents* for Accessories and Installation: Accessories	Added Percents* for Accessories and Installation: Installation
Mechanical type differential flow meter (single-point recorder)	$160	95	50
Electrical type differential flow meter (single-point recorder)	300	50	30
Mechanical type differential liquid level meter (single-point recorder)	185	40	45
Pressure gage (single-point recorder)	90	30	40
Thermometer (single-point recorder)	120	30	35
Electronic strip chart potentiometer pyrometer (six-point recorder	675	45	50
Electronic circular chart potentiometer pyrometer (single-point recorder)	315	15	20
Pneumatic control system components, including accessories†	300	..	45
Pneumatic transmission components, including accessories	175	..	25

* To be added to average base instrument cost for obtaining total installed cost including accessories.
† Does not include costs of compressors, manual bypass around control valve, etc.

Table II—Sample Calculation of Installed Costs of Instruments

(Based on installation of eight mechanical type differential flow meters, four with single-point recorders two with pneumatic control, two with pneumatic control and pneumatic transmission; and four mechanical type differential liquid level meters with mechanical transmission.)

Cost Item	Flow Meters		Liquid Level Meters	
Base instrument cost	8 × 160 =	$1,280.00	4 × 185 =	$740
Accessories	0.95 × 1,280 =	1,216.00	0.40 × 740 =	296
Installation	0.50 × 1,280 =	640.00	0.45 × 740 =	333
Control system components	4 × 300 =	1,200.00	.....	
Control system installation	0.45 × 1,200 =	540.00	.....	
Pneumatic transmission components	2 × 175 =	350.00	4 × 175 =	700
Pneumatic transmission installation	0.25 × 350 =	87.50	0.25 × 700 =	175
Total		$5,313.50		$2,244

Credit Swiping Nurses Hidden Losses

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AFTER reading Nick's letter, our group of management-aspiring engineers seized on "credit-swiping" as a subject for discussion and investigation. Nick had written, "Little wonder, Mac, that in labs like yours, interest lags in the lower levels. Here, everyone has his own projects for which he is responsible and on which, when it is finished, he writes a report—in his own name!!! I like that. My intellectual interest has reawakened . . ."

A year ago Nick had left our laboratory. We sensed his stated reason for resigning was merely pretext. This personal letter confirming our suspicion that he had simply had his fill of credit-swiping, having his work taken by a supervisor and handed up the line with no identification of Nick's part in it had outraged his sense of opportunity and justice.

From our consideration of this particular case we discovered that individually we felt keenly on this subject; that collectively we concluded that "something ought to be done about it." The first loss directly traced to the habit of promiscuous credit-swiping was the knowledge that walked "out the gate" as trained personnel left our organization.

Other Losses

Next we probed the losses among the people who remained, the ones who were also victimized, the static individuals who had once shown promise of generating profitable ideas. We decided that an equally great loss resulted from self-imposed curtailment of suggestions.

The third loss involved group behaviour. Why should group productivity sag because one individual suffered? We concluded sympathetic reactions developed within the social structure of the department. Individuals so victimized couldn't conceal their disappointment. Neighbors quickly sensed a flagging spirit. Common ties prompted working associates to soften the outraged feelings of the victim. Sympathy usually flowed to the victim; antipathy, toward the management.

Credit-swiping's fourth loss originated in the third. Certain ideas receiving management approval failed to achieve their potentialities. In one particular case, members of a branch laboratory evolved a plan for the internal organization of technical information. They had combined the needs of uniform practice, transmission of information, and training of personnel into a speedy, unique, schematic paper form. The director of central laboratories became interested, expanded the project, and invested sufficient money to insure a good trial. Even though they were available and willing to help develop and to "sell" the expanded system to the operating personnel, the originators of the scheme were promptly "frozen out." Although sponsored by the director, full development of the project was stymied by this instance of credit-swiping. When finally introduced, the system met indifferent acceptance. Old methods persisted.

The effect of the fifth type of loss may be felt by any industrial organization. A publicly held belief that all supervisors kidnap the brain-children of their subordinates certainly does not reflect a healthy reputation. Industry and management are placed on the defensive side of any argument.

How much does credit-swiping cost us? Losses so incurred aggregate to serious proportions. Moreover, they are hard to evaluate on a balance-sheet. They belong among the intangibles. Duration, importance, or severity can not be evaulated easily. The proportionate share chargeable to credit-swiping can hardly be extricated from morale and grievance factors. Like many grievance causes, the losses from credit-swiping are temporary and trivial. Mild cases might safely be not noticed, lest too much discussions overmagnify importance. Yet they can hardly be ignored because real damage can result from repeated impact of small doses; credit-swiping losses, like grievances, sometimes accumulate to serious proportions.

Low Morale

Credit-swiping definitely flourishes under conditions of low morale. Whenever morale sags under threat of impending lay-offs, the apparent rewards for successful credit-swiping loom more attractive. Any organization where promotion hinges on adept credit-swiping harbors many chronic offenders. While high morale can not guarantee elimination of credit-swiping, it does furnish the best insurance against the ravages of the habit.

The most deplorable characteristic is the prevalence of credit-swiping at all levels in an organization. Somehow we couldn't repress the impression that the intermediate levels of supervision and administration carry the worst reputation.

Yet ideas have to flow upward. The continuous regeneration of an organization depends upon that flow. We searched out usable techniques for promoting upward flow that differentiate thriving organizations from those that stagnate. The simplest key lay in substituting credit-giving for credit-swiping.

When we came to synthesizing a corrective program, our analysis cautioned ignoring credit-swiping among people at equal levels. The social

POINTS IN AN ANTI-CREDIT-SWIPING CAMPAIGN

1. Make sure that the suggestion box schemes provide expert help in organizing ideas into understandable form, providing, if necessary, assistance to such employees as feel the need. Make sure that idea-submitting employees are satisfied that their suggestions have had fullest consideration, including friendly interpretation.

2. Survey all supervisors in all levels to discover credit-swiping tendencies. Aim to differentiate among habitual offenders, occasional indulgers, rare resorters, and good examples of credit-givers. Make fuller use of exit-interviews to bring out this information.

3. Review management policies affecting procedures for handling ideas upward. Then review employees' understanding of those policies.

4. Review rating systems for technical personnel to make sure an equitable system for acknowledging credit exists for employees at all levels. Be sure due credit survives each upward transfer of ideas.

5. Have top management set a real, sincere example of credit-giving.

structure seemed to handle that condition, adequately and definitely. Ostracism and the outright "riding" that a group can give a member deters infractions of moral codes.

Charges of credit-swiping could not be lodged directly against offending supervisors without provoking strong reactions. Supervisors could be expected to react to criticism like other people, normally resenting charges or discipline for offenses that they felt present in their accusers. Consequently placing credit-swiping upon the supervisory conference's unsolved problem agenda presented the most promising approach. Following repetition of this analysis, individual supervisors could be encouraged to modify their viewpoints as prelude to altering their habits.

Technical personnel of the staff organization present a particularly thorny problem. As individuals highly trained in subjects that constantly challenge mental powers, ideas form a major portion of their stock in trade. These people deal freely in ideas—their own, their associates; and their competitors'. Proximity to inventions and patents where "original conception" is a critical ingredient, has conditioned engineers and scientists to a free interchange of information. As a group, they evolved their own ethics to fit their needs. Largely unwritten, those ethics command voluntary compliance. In this respect, technical personnel differ from men in the line organization. Accustomed to credit-giving, practising credit-taking often, engineers were not usually inclined to resort to credit-swiping for their own advantages. But they were frequently victims of credit-swiping practiced by non-engineering associates. The technical personnel's contributions to industry were too valuable and essential to be lost through non-cooperative reactions resulting from victimization. As in the case of supervision, the best approach to engineers appeared to lie through analysis of losses, discussion of characteristics, and challenge to constructive thinking. Engineers and scientists were too frequently victimized to expect them to be zealous in correcting their habits without preparation for a program.

A program finally evolved that would start with an anlysis of losses and causes, proceed through the human factors involved, and then lead to a conscious effort to encourage credit-giving. The salient features are outlined in the accompanying box.

Quarter Circle Rule for Latent Heats

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MANY times we have occasion to hunt up the latent heat of vaporization for some liquid in the handbooks and find that it is listed for some one temperature which is generally not the one sought. Ordinarily we are forced to use the Clausius equation or the Clapeyron formula, or as a last resort, to measure the heat experimentally. There is a simple relationship between the temperature, molecular weight, and latent heat of vaporization which is shown graphically in Fig. 2.

The curve for zero molecular weight is a quarter circle, and the curve for an infinite molecular weight is a straight line. The family of curves in between follows the formula $[(T - T_m)/(T_c - T_m)]^n + [(L - L_c)/(L_m - L_c)]^n = 1.0$, where n is a number between 1.0 and 2.0. The value of n varies inversely with the molecular weight in some fashion: when M. W. = 0, $n = 2$ and when M. W. = ∞, $n = 1$. Here: T = Any temperature between T_c and T_m; T_b = Boiling point temperature; T_m = Melting point temperature; T_c = Critical temperature; L = Latent heat of vaporization at $T_c = 0$; L_m = Latent heat of vaporization at T_m.

To use this method, one may determine the critical point (if it isn't known) from the following two formulas: $T_c/T_b = 1.5$, Guldberg-Guye Formula (T_c and T_b in absolute temperatures); and $T_c = T_m + T_b$, Prud'homme Rule. Both of these formulas are approximations, but work rather well. Fig. 2 was obtained empirically, by plotting the data for water, NH_3, CO_2, SO_2, Hg, CCl_4, and CH_3 Cl then running the best curves through. There were 63 points in all of the experimental data.

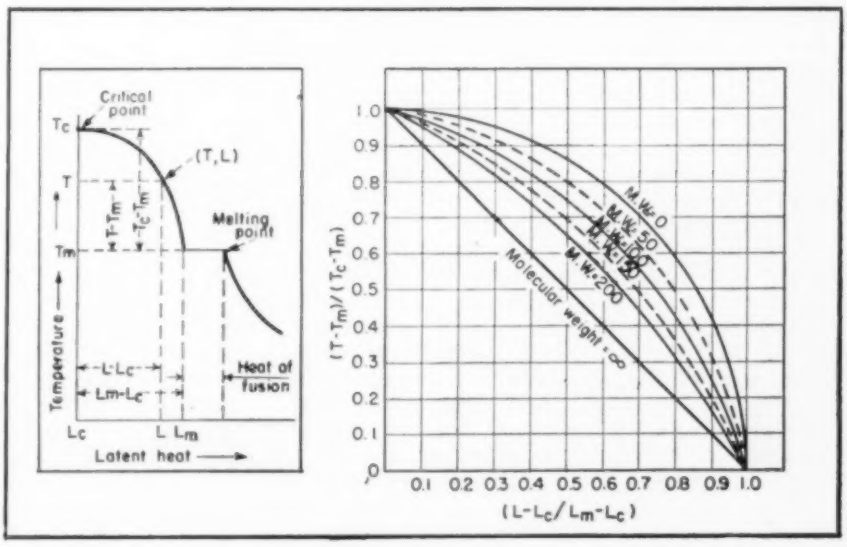
These curves are about as accurate as possible with the data at hand.

Someday when there are more data available on the different liquids of various molecular weights, perhaps the accuracy can be brought up to better than 99 percent. The curves are accurate to about 95 percent, or 5 percent error. In most cases the curves will give the latent heat more accurately than it can be determined by experiment, as those who have tried to measure the latent heat at high temperatures and pressures can testify.

The curves show graphically, what has been known for a long while: (a) The latent heat at the critical point is zero, (b) the latent heat at the boiling point is 50 to 85 percent of that at the melting point, (c) the latent heat at the melting point is the greatest for all temperatures ranging between the melting point and the critical point.

Just why it takes more heat percentage-wise to vaporize a low molecular weight liquid than a high molecular weight liquid I do not know, but it does, as is shown in the curves.

Left—Fig. 1 shows a sample latent heat vs. temperature diagram. Right—Fig. 2 is a plot of the relationship between temperature, molecular weight, and latent heat of vaporization. At the approximate boiling point, $(T-T_m)/(T_c-T_m)=0.5$



Evaluating Performance Of Cooling Towers

JAMES G. De FLON

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FORMULAS AND CHARTS PERMIT THE PLANT OPERATOR TO CHECK UP ON OPERATION OF COOLING TOWERS UNDER DESIGN AND OTHER CONDITIONS

Intended for the cooling tower user, rather than the designer, this article presents a simplified method of examining cooling tower performance which, although it omits certain refinements, will still enable a thorough analysis of the characteristics of individual mechanical and natural draft towers to be made under a variety of conditions of use.

WATER COOLING processes are among the oldest and simplest known to man. All that is required to cool water is to expose its surface to air. Some of these cooling processes are slow, such as the cooling of water on the surface of a pond; while others are comparatively fast, such as the spraying of water into air. These processes all involve the exposure of water surface to air with varying degrees of efficiency.

In these methods of water cooling the transfer of heat involves both a transfer of latent heat, in the form of the evaporation of a small part of the water, and a sensible heat transfer due to the difference in temperature of the water and the air. Since about 1,000 B.t.u. is required to evaporate 1 lb. of water, which is the heat that must be removed in cooling 100 lb. of water 10 deg. F., then for each 10 deg. of cooling roughly 1 percent of the water is lost by evaporation. In addition, a well designed atmospheric or mechanical draft cooling tower will lose not over 0.2 percent as spray. Therefore in cooling water 30 deg., for example, a loss of 3 percent by evaporation, plus 0.2 percent by spray (or 3.2 percent total) can be expected for each passage through the tower.

The sensible heat transferred in cooling water is much smaller than the transfer of latent heat. Expressed mathematically, the total heat transferred Q, in B.t.u. per hour, is equal to the sum of the sensible heat S, also in B.t.u. per hour, and the latent heat VL, where V is the pounds of vapor transferred per hour and L is the latent heat of evaporation at the liquid temperature, in B.t.u. per hour. Hence,

$$Q = S + VL$$

The magnitude of V depends on the mass transfer coefficient k, the exposed water surface A, in square feet, and the driving force Δp, or

$$V = kA\,\Delta p$$

The expression kA varies with the amount of water surface area exposed through drop and filming surface—that is, on the construction of the tower and on the air velocity. The driving force Δp is the difference in vapor pressure between the water at its actual temperature, and at a temperature which equals the wet bulb temperature of the air.

It is evident, then, that the water cannot be cooled below the wet bulb temperature of the entering air. The wet bulb temperature, or to be more precise, the adiabatic saturation temperature, represents the minimum temperature that the water would reach with infinite time of contact between water and air in a cooling tower. This must be kept in mind when designing a plant to use cooling tower water.

As process refinements have appeared, industry has demanded closer and closer control of its production units, resulting in more exacting demands upon cooling towers. In many plants, each additional degree of cooling has meant hundreds and even thousands of dollars per day in increased production. It has, therefore, been necessary for the cooling tower industry to produce towers which would supply the colder water more economically.

There are two types of cooling towers in general use today—the mechanical draft (Fig. 1) and the atmospheric (Fig. 2). Older types of apparatus for cooling water, i.e., the spray pond and natural draft chimney towers, have been almost entirely replaced by these two types of cooling tower. The objection to the spray pond is its limited performance and the nuisance created by the high water loss occurring during certain seasons of the year. The objection to the natural draft tower is its high initial cost and the serious reduction in performance experienced during periods of hot weather. Both the atmospheric and the mechanical draft towers are capable of cooling water to the same minimum temperatures. The economic situation, prevailing atmospheric conditions, the desired approach to the wet bulb temperature, and the amount of space available will indicate which type to select.

Mechanical Draft Towers

There are two types of mechanical draft towers in use today—the forced-draft and the induced-draft. In the forced-draft tower, the fan is mounted at its base and the air is forced in at the bottom and discharged through the top at low velocity. In the induced-draft tower, the fan is mounted on the roof of the structure and air is pulled upward and discharged at a high velocity.

The forced-draft type is fast losing favor as it is more often subject to the recirculation of the hot humid exhaust vapors back into the air intakes than the induced-draft type. This occurs under certain atmospheric conditions because the velocity of the humid exhaust air is so low that the suction created by the fans tends to draw it back into the tower. Since the wet bulb temperature of the exhaust air is considerably above that of the ambient air, there is a decrease in performance evidenced by an increase in cold water temperature.

Features of Design

Except for the location of the fans, the structural and operational features of the two types of mechanical draft towers are essentially the same. A cross-sectional view of the induced-draft tower with the various parts labeled is shown in Fig. 1. The entrained moisture is removed from the exhaust air by the drift eliminator, which is placed just above the spray chamber and below the fan. The water is pumped to the main header located in the top of the tower where it is distributed to the various nozzles. This water is sprayed up in a manner similar to that used in a spray pond and is intimately mixed with the exhaust air before dropping to the decks below. (In performance, the upspray distributing system represents the equivalent of adding 8 or 9 ft. to the height of the cooling tower over that of the gravity-type system.) The fall of the water is interrupted by the slat-type grids as it flows downward, countercurrent to the air. In flowing countercurrently, the coldest water contacts the driest air and the warmest water contacts the most humid air. Maximum performance is thus obtained since the temperature of all of the cold water approaches the wet bulb temperature of the entering dry air. This was not true of the older cross-flow and parallel-flow towers.

The performance of a given type cooling tower is governed by the ratio of the weights of air to water and the time of contact between water and air. In commercial practice, the variation in the ratio of air to water is first obtained by keeping the air velocity constant at about 350 ft. per minute per sq. ft. of active tower area and varying the water concentration (gallons per minute per sq. ft. of tower area). As a secondary operation, the air velocity is varied to make the tower accommodate the cooling requirement. The time of contact between water and air is governed largely by the time required for the water to discharge from the nozzles and fall through the tower

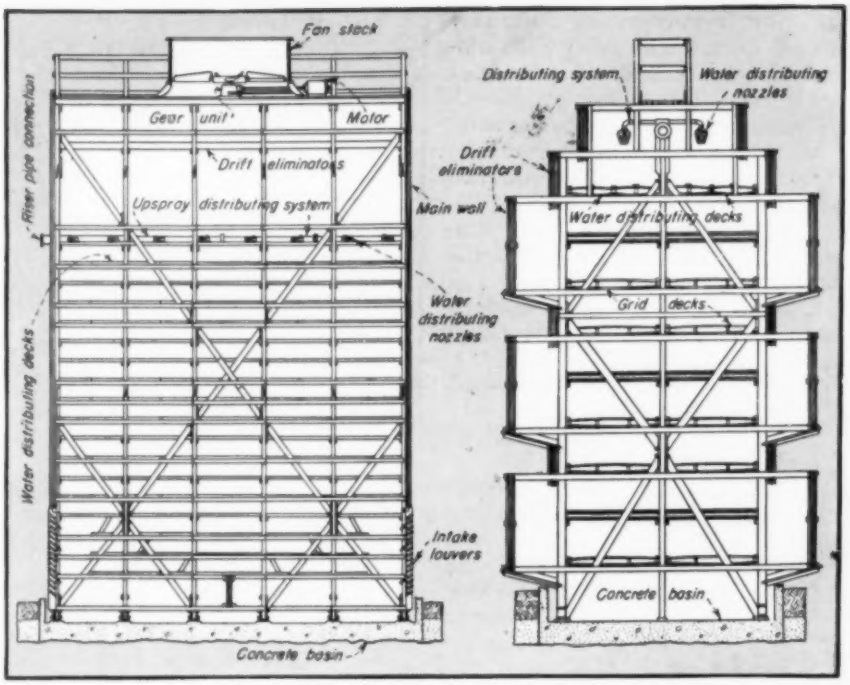


Fig. 1—Cross section of typical mechanical draft cooling tower with up-spray nozzles and drift eliminators above the spray chamber

Fig. 2—Cross section of atmospheric type cooling tower showing drift eliminators at sides to reduce airborne drift losses to a minimum

to the basin. The time of contact is, therefore, obtained in a given type of unit by varying the height of the tower. Should the time of contact be insufficient, no amount of increase in the ratio of air to water will produce the desired cooling. It is therefore necessary that a certain minimum height of cooling tower be maintained. Where a wide approach to the wet bulb temperature of 15 to 20 deg. F., and a 25 to 35 deg. cooling range is required, a relatively low cooling tower will suffice. (The approach is the difference between the cold water temperature and the wet bulb temperature; while the cooling range is the difference between the hot water temperature and the cold water temperature.) A tower in which the water travels 15 to 20 ft. from the distributing system to the basin is sufficient. Where a moderate approach of 8 to 15 deg. and a cooling range of 25 to 35 deg. is required, a tower in which the water travels 25 ft. to 30 ft. is adequate. Where a close approach of 4 to 8 deg., with a 25 to 35 deg. cooling range is required, a tower in which the water travels from 35 ft. to 40 ft. is required. It is usually not economical to design a cooling tower with an approach of less than 4 deg., but it can be satisfactorily accomplished with a tower where water travels 35 to 40 ft.

Fig. 3 shows the relationship of the hot water, cold water and wet bulb temperatures to the water concentration. From this, the minimum area required for a given performance of a well-designed counterflow induced-draft cooling tower can be obtained. Fig. 4 gives the horsepower per sq. ft. of tower area required for a given performance. These curves do not apply to parallel or cross-flow cooling since these processes are not as efficient as the counterflow process. Also they do not apply where the approach of the cold water temperature is less than 5 deg. These charts should be considered approximate and for preliminary estimates only. Many factors not shown in the graphs must be included in the computation and hence the manufacturer should be consulted for final design recommendations.

Water Concentration Effect

The cooling performance of any tower containing a given depth of filling varies with the water concentration. It has been found that the maximum contact and performance are obtained with a tower having a water concentration of 2 to 3 g.p.m. of water per sq. ft. of ground area. Thus, the problem of calculating the size of a cooling tower becomes one of determining the proper concentration of water required to obtain the desired results. A higher tower will be required if the water concentration falls below 1.6 g.p.m. per sq. ft. Should the water concentration exceed 3 g.p.m.

per sq. ft., a lower cooling tower may be used. Once the necessary water concentration is obtained, the tower area can be calculated by dividing the gallons per minute circulated by the water concentration in gallons per minute per sq. ft. The required tower size then is a function of the following:

1. Cooling range (hot water temperature minus cold water temperature).
2. Approach to wet bulb temperature (cold water temperature minus wet bulb temperature).
3. Quantity of water to be cooled.
4. Wet bulb temperature.
5. Air velocity through the cell.
6. Tower height.

To illustrate the use of the charts let us assume that we have the following cooling conditions:

Hot water temperature = 102 deg.
Cold water temperature = 78 deg.
Wet bulb temperature (Twb) = 70 deg.
Water flow rate = 2,000 g.p.m.

Laying a straightedge across Fig. 3 and connecting the points representing the design water and wet bulb temperatures, we find that a water concentration of 2 g.p.m. per sq. ft. is required. Dividing the quantity of water circulated by the water concentration, we find that the theoretical area of the tower is 1,000 sq. ft.

To obtain the theoretical fan horsepower, we use Fig. 4. Connecting the points representing 100 percent of standard tower performance with the turning point, we find that it will require 0.041 hp. per sq. ft. of actual effective tower area. Multiplying by the tower area of 1,000 sq. ft., we find that it requires 41.0 fan horsepower to perform the necessary cooling.

Suppose that the commercial tower size is such that the actual tower area is 910 sq. ft. We can still obtain the cooling equivalent to 1,000 sq. ft. of standard tower area by increasing the air velocity through the tower. Within reasonable limits, the shortage of actual area can be compensated for by an increase in air velocity through the tower which, in turn, requires a higher fan horsepower. Our problem then becomes one of increasing the performance of the smaller tower by 10 percent. From Fig. 4, by connecting the points representing 110 percent of standard tower performance and the turning point, the fan horsepower is found to be 0.057 hp. per sq. ft. of actual tower area, or $0.057 \times 910 = 51.9$ hp.

On the other hand, suppose the commercial tower size is such that the actual tower is 1,110 sq. ft. Then the cooling equivalent to 1,000 sq. ft. of standard tower area can be accomplished with less air and less fan horsepower. By the use of Fig. 4, the theoretical fan horsepower for a tower doing only 90 percent of standard performance is found to be 0.031 hp. per sq. ft. of actual tower area or 34.5 hp.

This illustrates how sensitive the fan horsepower is to small changes in tower area. The importance of designing a tower which is slightly oversize in ground area becomes immediately apparent.

Let us assume now that we have the same cooling range and approach as used in the first example, except that the wet bulb temperature is lower. The design conditions would then be: Water flow rate = 2,000 g.p.m.; cooling range = 24 deg.; wet bulb approach = 8 deg.; hot water temperature $T_1 = 92$ deg.; cold water temperature $T_2 = 68$ deg.; and wet bulb temperature $Twb = 60$ deg.

From Fig. 3 we find the water concentration required to perform the cooling is 1.75, giving a theoretical tower area of 1,145 sq. ft. as compared with 1,000 sq. ft. for a 70 deg. wet bulb temperature. This shows that the lower the wet bulb temperature for the same cooling range and approach, the larger the area of the tower required and the more difficult the job.

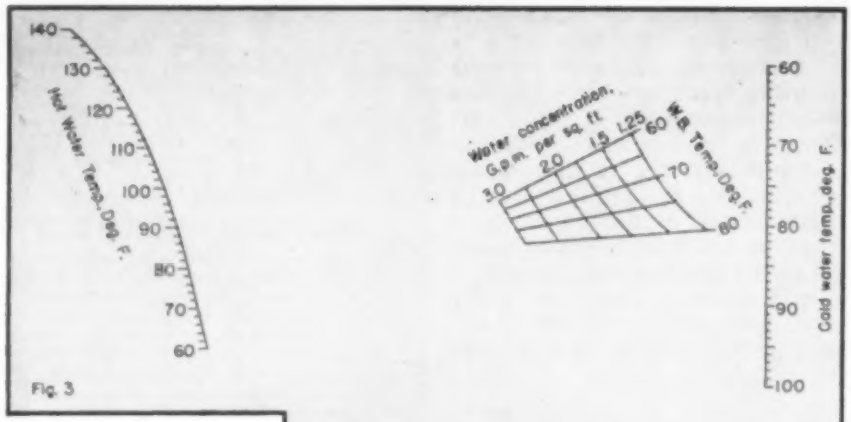


Fig. 3

Fig. 3 — Performance curve of a counterflow, induced draft cooling tower with up-spray distribution system containing 24 ft. of filling

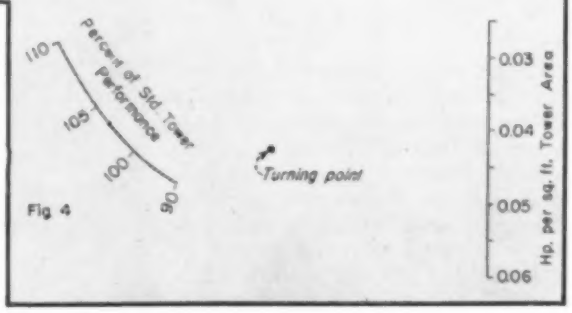


Fig. 4

Fig. 4—Fan horsepower chart for induced draft cooling towers with 24 ft. of filling

Checking Existing Towers

The problem of estimating the performance of an existing tower at other than design conditions is often encountered by the plant operator. For example, suppose we have a tower that was designed for the following conditions: Water flow rate = 1,000 g.p.m.; range = 30 deg.; approach = 10 deg.; $T_1 = 110$ deg.; $T_2 = 80$ deg.; and wet bulb temperature = 70 deg.

What will the cold water temperature T_2 be when the wet bulb temperature Twb drops to 60 deg., providing of course, that the heat load and water quantity remain constant? From Fig. 3, we find that the water concentration is 2.0 g.p.m. per sq. ft. at design conditions. This water concentration does not change since the volume of water and the tower area remain constant. With the water concentration at 2.0 and the wet bulb temperature at 60 deg., by adjusting the angle of the straight edge on Fig. 3 until we obtain a 30 deg. differential between the hot water and cold water temperatures, we find the hot water temperature to be 103 deg., and the cold water temperature to be 73 deg.

Suppose now, that the above designed tower had 1,500 g.p.m. flowing through it, and the total heat load remained constant, what would the cold water temperature be when the wet bulb temperature is 65 deg.? The design heat load was $1,000 \times 8.33 \times 30 = 250,000$ B.t.u. per minute. The new cooling range (heat load remaining constant) when circulating 1,500 g.p.m. over the tower would be $250,000/1,500 \times 8.33 = 20$ deg.

Theoretically, the design area of the tower from Fig. 3 was 500 sq. ft. (1,000 g.p.m. ÷ 2.0 g.p.m. per sq. ft. = 500 sq. ft.). The water concentration when circulating 1,500 g.p.m. is

1,500/500 = 3.0 g.p.m. per sq. ft. Now, referring to Fig. 3, with a water concentration of 3.0 g.p.m. per sq. ft. and 65 deg. wet bulb temperature, adjust the straight edge until a difference of 20 deg. exists between the hot water and cold water temperatures. This shows the hot water temperature to be 100 deg. and the cold water temperature to be 80 deg.

This indicates that the possibility of a lower cold water temperature (to be obtained by the lower existing wet bulb temperature) was lost due to the effect of the increased water quantity.

Performance curves for cooling towers are furnished by the cooling tower manufacturer to show the variation in performance with change in wet bulb and hot water temperature, while maintaining water quantity constant.

Centrifugal type non-clogging nozzles are used in upspray cooling tower distributing systems. In upspray distributing systems, a pressure of 7 psi. ga. is common practice; however, 5 psi. ga. is adequate. Nozzles of this sort do not depend on small orifices to obtain minimum drop-size but, rather, upon centrifugal force. The water is given a spiral action by its tangential entrance into a spiral chamber. A dome-shaped approach to the discharge orifice increases this spiral action as the water approaches the discharge orifice. The whirling action, which generates the necessary velocity for fine breakup, assures uniform drop-size and efficient water distribution over a maximum area. This formation of uniformly small drops assures maximum contact with air, resulting in high cooling efficiency.

Atmospheric Cooling Towers

A cross-sectional view of a typical atmospheric cooling tower is shown in Fig. 2 In atmospheric towers, the water is pumped to the top of the tower, where it is discharged through a distributing system. As the water begins its downward flow, it is broken up and redistributed by the decks that comprise the filling of the tower. This action continually creates newly exposed cooling surface for contact with the air which passes horizontally through the tower. The redistribution insures even concentration of water in the tower during its entire fall.

Although initial cost for an atmospheric cooling tower (designed for a 3-mile wind) is about the same as that for a mechanical draft tower, there are certain important limitations governing its performance. It must be located broadside to the prevailing wind in an exposed area. Any surrounding structures, hills or other barriers would tend to block off the wind.

Originally, the main objection to atmospheric towers was the excessive spray loss occuring during periods of high winds. This high loss was caused by the lack of a method of separating the entrained water from the air in the conventional louver-type tower. However, most manufacturers now have solved this problem by the use of drift eliminators in the louvers.

The method of determining the size and performance of an atmospheric type tower is shown on the remaining charts, Figs. 5 to 9. The purpose of these charts is to show a method of estimating the approximate size of an atmospheric type cooling tower to meet a given demand. It should be noted particularly that the cooling capacity of any tower, with a given wet bulb temperature and wind velocity, varies with the water concentration. Thus, the problem of calculating tower size becomes nothing more than that of obtaining the correct water concentration for one of chosen height, which will operate under a certain wind velocity and wet bulb temperature. Once this water concentration factor is obtained, the area of a given height tower can easily be calculated by dividing the gallons per minute circulated by the concentration factor.

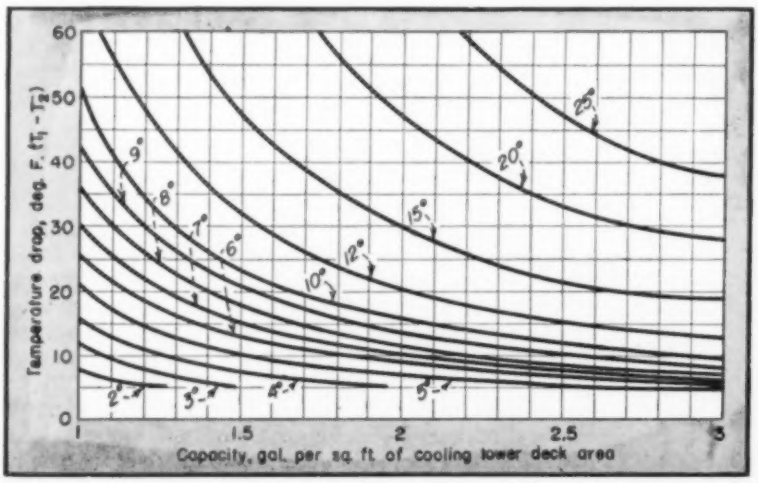


Fig. 5—Capacity curves for atmospheric type cooling, based on a 12-deck tower, 35 ft. high, with 70 deg. F. wet bulb and 3-mile wind

Concentration Determinants

The concentration required to produce desired cooling depends primarily on the following conditions:

1. Temperature range, T_1—T_2.
2. Approach to wet bulb temperature, T_2—*Twb*.
3. Tower height.
4. Wind velocity.
5. Wet bulb temperature, *Twb*.

It is easily seen that because of the infinite number of possible combinations of these values, it is impractical if not impossible to have one curve from which to obtain the correct concentration factor. Fig. 5 gives the required concentration for cooling water through a certain range and with a certain approach to the wet bulb temperature, but this curve is based on a particular set of conditions, including a wet bulb temperature of 70 deg. F., a tower height of 35 ft., and a wind velocity of 3 m.p.h. Let us assume that the conditions given are unity. Then should any of these three values change, the concentration would have to be corrected for the new conditions by using one or more of the correction factors shown on Figs. 6, 7 and 8.

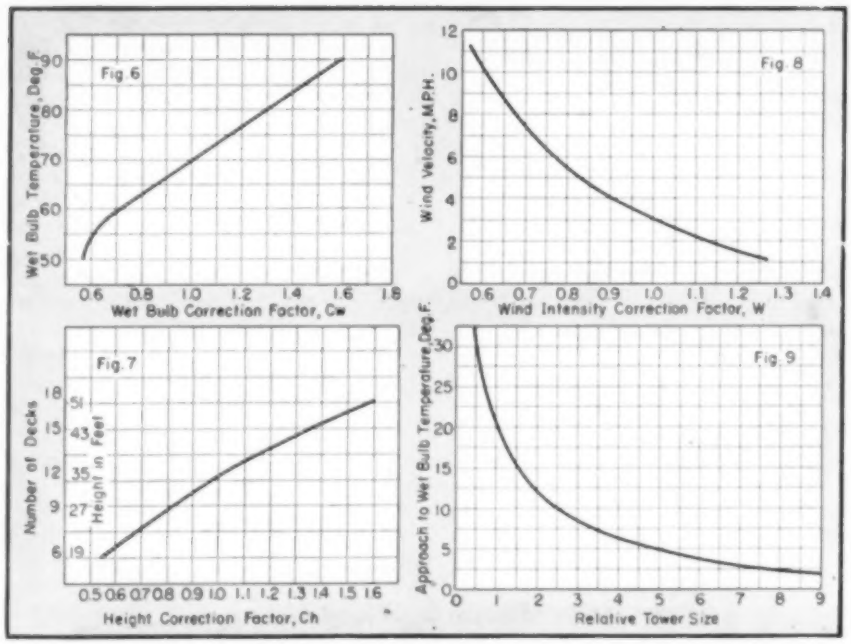
Let us see how a variation of any of the three aforementioned conditions would affect the water concentration.

1. *Wet Bulb Temperature*—Theoretically, a cooling tower cannot cool water to a temperature lower than the prevailing wet bulb temperature. Being limited by this fact, one is more interested in the economic approach of the cold water temperature to the latter temperature. Air has a greater capacity for absorbing heat at the higher wet bulb temperatures. With lower wet bulbs air, in passing through the tower, must have a greater temperature rise to accomplish the same cooling. Therefore, to obtain the same approach at the lower wet bulb temperatures it is necessary to reduce the concentration.

2. *Tower Height*—In general, it is found in atmospheric as well as mechanical draft towers that the greater the cooling range and the closer the approach to the wet bulb temperature, the higher will be the tower required to give sufficient time of contact between water and air to accomplish the desired cooling. In atmospheric towers the performance is lim-

ited by both maximum and minimum water concentrations. Should the water concentration fall below 1 g.p.m. per sq. ft. of tower area, it will be necessary to employ the next size higher tower. This is because in extremely light water concentrations the water will not be uniformly distributed and the predicted performance will not be achieved. Should the water concentration exceed 3 g.p.m. per sq. ft. of tower area, it will then be necessary to choose the next size lower tower. The higher water concentrations tend to blanket the tower and will not allow sufficient air to pass through to accomplish the cooling shown on the curves.

3. *Wind Velocity*—The higher the wind velocity the greater the amount of air that goes through the tower. This results in greater cooling. Therefore, when the wind velocity is higher, the concentration can be greater and still obtain equal cooling.*



Performance factor curves for atmospheric type towers: Fig. 6, Wet bulb factor; Fig. 7, Tower height factor; Fig. 8, Wind intensity factor; Fig. 9, Variation of tower size with approach to wet bulb temperature

Computing the Size

To calculate the size of an atmospheric type cooling tower with effective width of 12 ft. the following general formula may be used:

$$L = \frac{G.p.m. \times W}{C \times 12 \times Cw \times Ch}$$

where L = length of tower in feet; $G.p.m.$ = quantity of water in gallons per minute; W = wind correction factor; C = concentration of water per square foot of cooling tower area; Cw = wet bulb correction factor; Ch = tower height correction factor; T_1 = inlet temperature; T_2 = outlet temperature; $T_1—T_2$ = temperature range; Twb = wet bulb temperature; and $T_2—Twb$ = approach to wet bulb temperature.

Problem 1—Determine the length of a 35-ft. high tower required to cool 1,500 g.p.m. from 90 deg. F. to 75 deg. F. with a 70 deg. F. wet bulb temperature and a 3 m.p.h. wind. From these conditions we know that the approach $T_2—Twb = 5$ deg. F. and the range $T_1—T_2 = 15$ deg. F. From Fig. 5 it is found that these two values require a concentration of $C = 1.17$. The correction factors, Ch, Cw and W will all be equal to unity, as shown on their respective correction factor curves, because Fig. 5 is based upon values equal to those given in the problem. Substituting the corresponding values in the above formula we find that a tower 107 ft. long is required.

Problem 2—Let us take the same conditions that exist in Problem 1 and see what the effect will be when the wind velocity is increased to 5 m.p.h. From Fig. 8, when the wind velocity is 5 m.p.h., $W = 0.83$. Substituting this value for W in the formula, we find that an 88.5 ft. long tower is required.

Problem 3—Again assume the same conditions as Problem 1, except that due to space considerations it is necessary to have a 51-ft. high tower. From Fig. 7, when tower height is 51 ft., $Ch = 1.63$. Substituting the new Ch in the formula we find that a 65.6 ft. long tower is required.

Problem 4—Assume the conditions of this problem are identical to those of Problem 1, except that water has to be cooled from 85 to 70 deg. F., and the wet bulb temperature is 65 deg. F. From Fig. 6, when the wet bulb temperature is 65 deg. F., $Cw = 0.86$. Substituting this factor in the general formula we find tower length to be 124 ft.

Problem 5—Once a tower is installed the problem often arises of determining what cold water temperature one can expect under conditions differing from those for which the tower was designed. For example, let us take the tower calculated for Problem 1. This tower is 35 ft. high, 12 ft. wide, and 107 ft. long. What cold water temperature T_2 can be expected when the wet bulb temperature is 60 deg. F., the wind velocity is 4 m.p.h., the cooling range is 15 deg. F., and the water circulation rate is 2,000 g.p.m.?

The wet bulb temperature correction factor Cw from Fig. 6 is 0.71. The wind velocity correction factor W from Fig. 8 is 0.90. By substituting these values in the general formula and solving for water concentration, we find that $C = 2{,}000 \times 0.90/(107 \times 12 \times 0.71 \times 1) = 1.97$ g.p.m. per sq.ft.

Turning to Fig. 5, we find that when the cooling range is 15 deg. F. and the water concentration is 1.97, the approach to the wet bulb temperature is about 9 deg. F. This means that the cold water temperature will be $60 + 9 = 69$ deg. F.

Approximate Only

The information given here is presented only to show the more important factors that affect the design of atmospheric type cooling towers. Space does not allow consideration of the effect of excessive or insufficient concentration, higher relative humidity, change in wind direction, and other finer points which must be analyzed for proper cooling tower selection. Therefore, it must be emphasized that the cooling tower sizes calculated in the examples given here are only approximate. This survey, while it presents the essentials, has purposely been kept as non-technical as possible in order that it may serve as a guide to plant operators in evaluating cooling tower performance.

* In deciding upon a design wind condition, it is well to bear in mind that there is a period occurring during the day and night in which the prevailing wind shifts. When this occurs, there is a short period when there is little or no air movement. During such period, the tower water temperatures will rise from 2 to 5 degrees, depending on the duration of the calm and the design wind velocity. This should be evaluated in determining a design wind velocity. However, one should be aware of the fact that many atmospheric towers are designed to successfully operate at a zero wind condition.

Natural Gas Storage

NATURAL gas is meeting one serious difficulty as it assumes the responsibility of city supply for utility gas companies. That difficulty arises from the fact that the demand for gas is very much greater in the winter season than in the summer months. Hence, some of the equipment must be idle in periods of small demand, or some special method must be found to increase supplies of gas at the period of peak load.

Storage of natural gas over long periods is not practical under most circumstances. For example, a gas company cannot bring large quantities of gas from Texas to Detroit during the summer for use in the winter time. There is no practical means of storing such gas in large quantities for periods of several months. There are a few circumstances under which such seasonal storage is possible. For example, near Buffalo gas is brought and stored underground at points where old exhausted natural gas wells are located. Such wells are re-pressured in the summer and drawn on in the winter with great advantage for the local distribution system. Comparable methods of storage underground have occasionally been attempted in other areas. Studies have recently been reported by J. R. Bircher on use of sandstone strata in the Middle West for this purpose. In that case, the gas happens to be coke oven gas, but the principle is the same.

Precaution

One extra precaution must be taken according to the experiments conducted by Bircher. The gas has to be so purified as to eliminate gum forming components that would otherwise choke up the porous rock and either prevent access of fresh gas or prevent escape of the gas when it is drawn on at time of need. Incidentally, his work also demonstrates that the coke oven gas introduced into the rock may pick up some important natural gas components from the sand, and thus be recovered with higher heating value than the gas which is pumped into the sandstone.

Another recent development was undertaken on a small scale by the engineers of Stone and Webster in cooperation with Public Service Co. of Northern Illinois. These engineers report successful use of buried pipe for underground short-term storage at very high pressure. The trials at Kankakee used 50 lengths of steel pipe 40 ft. long by 24 in. diameter. Compression to 2,240 lb. per sq. in. enabled storing of methane in this experimental unit at unexpectedly high rates. Theoretically this storage unit should have held 160 times its normal volume at this high pressure. Actually the greater compressibility of the material combined with low ground temperature permitted actual storage of 230 cu. ft. of gas in one cubic foot of space.

Numerous other seasonal and short-term peak load storage projects are being investigated by gas engineers. Apparently some of these are readily adaptable to use at process industry plants which must have some sort of a stand-by fuel facility for emergency use.

The work referred to will be found described in American Institute of Chemical Engineers proceedings of the St. Louis meeting of May 11, 1947, an article by J. Russell Bircher, Battelle Memorial Institute, Columbus, Ohio; and in *American Gas Association Monthly*, April 1947, page 171, an article by C. R. Claxton, M. G. Markle, and D. V. Meiller.

Gas Reserves Rise

NATURAL gas underground in the United States is known to exist in larger quantities than were in recognized reserves at any time heretofore. American Gas Association has released a report of its special committee on natural gas reserves which give figures of the estimated underground supply in proven areas as of Dec. 31, 1946.

At the beginning of last year the recognized reserves were 148 trillion cu. ft. Revisions, extensions, and discoveries of the year added 17 trillion. Production from known reserves was 5 trillion, leaving a net increase of 12 to give the year-end estimate of 160 trillion cu. ft.

Comparable data from American Petroleum Institute for crude oil are expressed in trillions of barrels in the proven reserves. At the end of 1945 these were 19.94 to which revisions, extensions, and new discoveries added 2.66 during the year. Production eliminated 1.73. The year-end estimate was therefore 20.87 trillion barrels of crude in the ground, a record high.

The liquefiable components of natural gas reserves were also increased during the year. At the end of 1946 the net recoverable reserves of natural gas liquids (principally propane and butane) were about 3.35 billions of barrels, according to the A. G. A. estimates. This total includes both the liquids associated with natural gas and those associated with petroleum occurrences.

It is interesting to note that in the case of gas, gas liquids, and crude oil, the discovery of reserves has been continuing at a higher rate than consumption for sometime past. The percentage of recovery from reserves has also been increased due to improved technology.

Joint report of American Gas Association and American Petroleum Institute committees on gas and oil reserves. Published by American Gas Association Monthly, April 1947.

Tar Emulsions

A method of demulsification of water gas tar emulsions, which completely demulsifies and cuts time of treatment from 36 to 14 hr. was described before the Joint Production and Chemical Committee Conference of the American Gas Association, at its June meeting, in a paper presented by S. A. Petrino, Engineer of Production of the Kings County Lighting, Brooklyn, N. Y. The process involves the use of a catalyst in conjunction with the customary heat treatment.

The emulsion is pumped into a 50,000-gal. magnesia insulated open heater, and certain catalysts are added. The emulsion is then heated to a temperature of 200 F.-210 F. with steam at 125 psi. and held at that temperature for six hours. The steam is then cut off and the tar is allowed to settle out and is withdrawn at the bottom of the heater.

In commenting on the operating problems, Petrino said that an important factor in the success of the process was the insulation of the open heater. One-inch thick 85 percent magnesia blocks were used, with a weather-proof cement and asbestos coating.

EDITORIAL VIEWPOINTS

Sidney D. Kirkpatrick and Staff

ONE DOWN, TWO TO GO

IT HAS taken more than a year of hesitation, delay and bungling to settle only one of the three basic points at issue between Russia and the United States in the U. N. Atomic Energy Commission. Mr. Gromyko's carefully guarded agreement to international inspection seems to have removed one obstacle. The two that remain are: (1) International operation of the "dangerous" phases of atomic production and (2) the abolition of the veto on punishment of violators.

Ever since the latter was first proposed by Bernard Baruch at Hunter College, June 14, 1946, it has been the most discussed of all the Soviet-American differences. Yet some observers, including David Lilienthal, believe that international operation offers the real stumbling block. Unless and until such an organization is set up and working satisfactorily, the United States will not surrender its technique nor supply of nuclear fuel. This has the advantage that neither the Soviet Union nor any other country would have direct control of this technique. On the other hand, there would inevitably be friction among many of the nations that might wish to dictate the location of plants and the disposition of their products and byproducts.

There are many who feel that Russia's attitude may force us to set up an international control system without the cooperation of the Soviet Union. Others believe the year's effort has proved that the world is not yet ready for the necessary surrender of sovereignty, that our offers should be withdrawn while we redouble our efforts to keep ahead in the inevitable race in atomic armament. Such indeed is a sorry commentary on our prospects for world peace in this generation.

ATOMIC RESEARCH

UNFORTUNATE difference of opinion has developed between Atomic Energy Commission and certain industrial executives over the planning and management of atomic research. This is most unfortunate.

Naturally we cannot be fully advised regarding the cause of the controversy at Oak Ridge over the allocation of certain research projects. But we can justifiably criticize any official action which tends to discourage that research or to put it under any management less than the best. Recent events seem to indicate that such unfortunate result is developing.

It should be noted that Atomic Energy Commission can without difficulty protect both itself and the public. If any investigations are being made anywhere without due regard for secrecy, the AEC has abundant authority to step in and provide essential security measures. Furthermore, if results of research, whether patentable or not, bear upon any military features of atomic development even remotely, there is not the slightest doubt that A.E.C. can take over for use, and probably for ownership and control, any such results, including patentable inventions.

We do not quarrel with those features of the law. We believe in them. But they should be administered in such manner as not to antagonize any of the more important research activities which can be commanded for this vital new area of scientific investigation. That precaution has not been observed. Numerous industrial groups find their activities in this field so threatened that they are inclined to withdraw from worthwhile undertakings. We could, but we will not, name several important companies so disturbed.

It is a great disservice to the American people to have such a situation develop at this early stage. Cooperation between important industries and the Atomic Energy Commission is more valuable than any whims or preferences of either industry or officials. A sound basis for genuine cooperation must be established. It is important that Atomic Energy Commission take the lead by inspiring confidence in the broad programs which it must supervise.

MORE COMPARTMENTALIZATION?

SOME observers see another rather disturbing trend in AEC's direction of its research and development program. There has been an increasing and perhaps necessary and desirable emphasis of late on the military aspects of atomic energy. Projects leading toward such objectives are being largely concentrated in the hands of industry where experienced engineers are available to translate them into useful applications. On the other hand, the more promising projects for peaceful applications are being routed to the universities where the research scientists are available to work out the underlying theories and principles. The result, whether intentional or not, is to erect a barrier between the engineers in industry and the scientists in the universities. This is an unhappy situation for all concerned. It can best be remedied by assigning projects to those organizations in which both the basic research applications and their engineering applications can be carried on simultaneously.

A BIG IMPROVEMENT

A SOUND national fertilizer policy is needed. So says Secretary of Agriculture Clinton Anderson. And we agree with him enthusiastically. We also agree with the Secretary that the previous bill, S. 1251, is not the right way in which to reach a sound fertilizer policy. We unreservedly condemn that bill, for it is another vicious attempt to put the Government into the fertilizer business.

The Department of Agriculture has drafted its idea of the way in which a sound fertilizer policy could be and should be formulated. We do not agree with every detail. That is not surprising. We do agree, however, that this Department proposal is vastly superior to anything else thus far presented to Congress.

We believe that the Senate hearings of June have proved conclusively that S. 1251 is a thinly veiled New Deal effort to get T.V.A. and the Department of Interior deeper into chemical industry. We believe that Secretary Anderson sincerely proposes his alternative with the hope that it will keep the Government out of business as a competitor with private enterprise. Process industry generally, and the fertilizer industry in particular, will support this idea.

We hope that Congress will take a fresh start when it comes back next Fall or Winter, working from the Anderson proposal and repudiating the inexcusably bad measure which has been before it during recent months. All of the public, especially the farmers, will benefit from such fresh start.

AT LAST A CENSUS!

CONGRESS apparently is going to give the Bureau of the Census approximately $4 million with which to take a census of manufactures next year. This will give us for the first time since 1939 an accurate national review of the activities of industry, with data for the calendar year 1947.

Process industries have an important part to play in this job. It is our obligation to assist the Census technical staff in formulating the best possible forms for the questionnaires. Each company should acquaint itself with the facts that will be called for. Then when the inquiries go out next January, there will be no excuse for delay in making the required returns.

The data which will come from this census of manufactures are much too valuable to be delayed or to be limited in accuracy or usefulness by any lack of cooperation from industry. Funds granted for the Bureau are not enough for the best possible job. Industry must make up the deficit by prompt, intelligent cooperation. All will benefit thereby.

"PORK" IN POLLUTION

PREVENTION of stream pollution by federal investigations, recommendations, and perhaps mandatory orders, has been expected from the present Congress. A major question until lately has been whether the Public Health Service should have only the authority to investigate and recommend, or whether it should be given authority to order corrective measures.

Now comes a complicating factor, General Fleming of the Federal Works Agency has suggested to the Senate Committee that a program of federal construction be superimposed on the program of investigation and correction. The idea is that Uncle Sam will give "grants in aid." And naturally General Fleming would like the Federal Works Agency to make the grants and supervise the federal spending.

This introduces a strong "pork-barrel" characteristic. It changes substantially the objective of the measure. Later it may be that the federal government will have to enter as a construction agency. But it is highly undesirable that the primary measure regulating pollution of waterways should take on this aspect. We hope that the "pork" will be eliminated and that a sound bill for Public Health Service investigation will be enacted as a step toward solving this important national problem. This is such a self-evident truth that it may not seem worth while repeating. Actually it has not been sufficiently observed as a basic principle in much of the argument during the past year. For that reason, if for no other, it deserves re-stating. All chemical engineers and executives should consciously campaign for this principle until it is widely recognized and accepted.

PETROLEUM SCARCITY

SCARCITY of petroleum products during the coming winter seems inevitable. There is plenty of crude. There is plenty of money for equipment to process the crude. There are abundant facilities for moving products to market. So what?

Washington interference with construction programs has prevented the expansion of refinery facilities at the necessary rate. As a result engineers in the process industries must get ready to do without petroleum products in the quantities wanted. The general public may be chilly in spots for want of fuel oil. Even gasoline may be needlessly scarce in some areas. But it is to be hoped that the industry will not be blamed by the public and by the politicians when the guilt must rest with Washington bureauracy.

INTERCHANGEABLE FUELS

UNDERTAKING to fix a national policy for natural-gas development and interstate transportation, the Federal Power Commission held last year an important series of hearings. Its technical staff has prepared a series of reports on various phases of the question.

The outstanding technical conclusion implied, though not so simply expressed, is that many fuels are now interchangeable because of modern fuel processing technology. This recognition of the importance of the chemical processing of fuels is one of the most satisfying actions which has come from government sources in a long time. Chemical engineers will be gratified at the clear thinking shown by the Commission staff. That staff deserves sincere compliment for sound technical review of a very complicated subject, which was presented in a protracted and not too orderly series of hearings.

EQUAL LABOR RIGHTS

ONE fundamental principle seems undisputably clear as a result of the long and bitter controversy in Washington over labor legislation. This is a principle easily stated but difficult in application. It is that management and organized labor must meet as equals if there is to be any sound, fair basis for collective bargaining.

Whatever Congress and the President may ultimately work out for the regulation of labor practices—and passage over presidential veto of the Taft-Hartley bill by the 80th Congress is only part of the job—that principle of equality must become governing in practice.

THE PLANT NOTEBOOK

Theodore R. Olive, ASSOCIATE EDITOR

$50 CASH PRIZE FOR A GOOD IDEA!

Until further notice the editors of *Chemical Engineering* will award $50 cash each month to the author of the best short article received that month and accepted for publication in the Plant Notebook. The winner each month will be announced in the issue of the next month: e.g., the July winner will be announced in August, and his article published in September. Judges will be the editors of *Chemical Engineering*. Non-winning articles submitted for this contest will be published if acceptable, in that case being paid for at applicable space rates.

Any reader of *Chemical Engineering*, other than a McGraw-Hill employee, may submit as many entries for this contest as he wishes. Acceptable material must be previously unpublished and should be short, preferably not over 300 words, but illustrated if possible. Neither finished drawings nor polished writing are necessary, since only appropriateness, novelty and usefulness of the ideas presented are considered.

Articles may deal with any sort of plant or production "kink" or shortcut that will be of interest to chemical engineers in the process industries. In addition, novel means of presenting useful data, as well as new cost-cutting ideas, are acceptable. Address Plant Notebook Editor, *Chemical Engineering*, 330 West 42nd St., New York 18, N. Y.

JUNE WINNER

A $50 prize will be issued to

WALTER R. SWENSON
Assistant Chief Draftsman
The Dorr Co., New York

For an article describing a method of maintaining a series of fixed but accurately controlled predetermined pressures on a processing system that has been judged the winner of our June contest.

This article will appear in our August issue. Watch for it!

May Contest Prize Winner

AUTOMATIC VALVES FOR CONTROL OF SMALL FLOWS OF ACIDS OR OTHER CORROSIVE MATERIALS

KARL E. KUNKEL
Associate Engineer, R. B. MacMullin Associates
Niagara Falls, N. Y.

IN PILOT PLANT operations, and occasionally in full scale work, it is necessary to provide automatic valves for the control of very small flows of acid or other fluids. The devices here described* can be used effectively with any fluid which does not attack the glass or rubber parts.

Fig. 1 shows an air-operated valve, which is fundamentally an automatic pinch clamp. This was designed to handle a flow of 0-50 c.c. per min. of 30 percent HCl. It was operated by the output air pressure from a pH controller having both proportional and automatic reset functions. It is important with this valve, as well as an electrically operated valve to be described later, that there be no "dead zone" at either end of the stroke. That is, full shut-off should occur just as the air pressure reaches zero, and the full-open position should not occur before full pressure is applied to the diaphragm.

Referring to Fig. 1, the full-closed position is adjusted by raising or lowering the anvil with the air pressure off. The full-open position is determined by the proper selection of tubing diameter and stroke of the lever; that is, the inside diameter of the tubing should be just slightly greater than the stroke of that portion of the lever which bears down upon it. Operation of this valve may be reversed by interchanging the positions of the fulcrum and anvil.

Slightly larger flows could be handled by the same size tubing merely by increasing the head. By changing the tubing size and lever ratios, fairly large flows may be accommodated, although it would be advisable to use a larger diaphragm motor for tubing sizes above ½ in.

An electrically operated valve based on the same pinch cock principle was also built, using a proportioning type control motor giving 1,500 in.-lb. output torque and driving a crank arm of variable throw, to which an adjustable push rod was attached. The bottom of the rod carried a plate to bear against the rubber tubing which in turn was supported on an anvil. Stroke and shut-off were readily adjusted, while the valve action could easily be reversed by moving the crank arm to the opposite side of the shaft.

In assembling the valve mechanisms of both the air-operated and electric types it is particularly important that

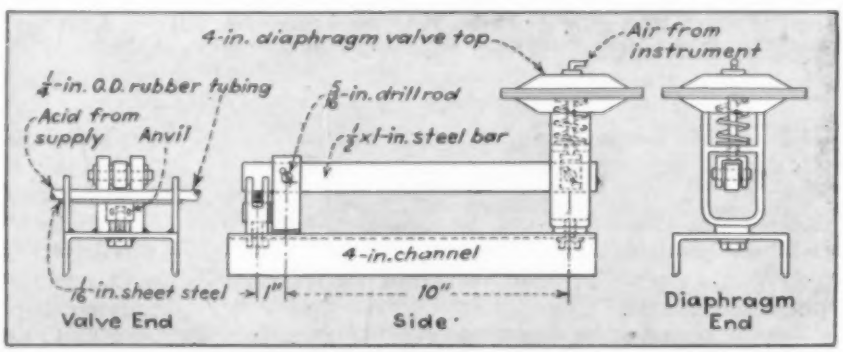


Fig. 1—Diaphragm motor and air operated pinch valve

*These devices were developed and tested by the writer while he was employed in the Research and Development Department of the Mathieson Alkali Works, Inc.

all joints be carefully fitted; "play" causes dead zones and poor control. The motors selected were deliberately oversize in order to overcome friction. The frameworks were made very heavy and rigid to avoid erratic flows due to deflection.

Fig. 2 shows a constant level controller assembled from standard glass tubing and pipe. The capacity of this controller is limited to a few liters per minute by the diameter of the glass tubing which can be closed off effectively by the buoyancy of the float. The maximum head against which it will operate is about 12 ft. For larger flows, a constant overflow tank, or a lever and float system would be more satisfactory.

This constant-head device may be converted to a constant-flow device merely by providing a suitable orifice

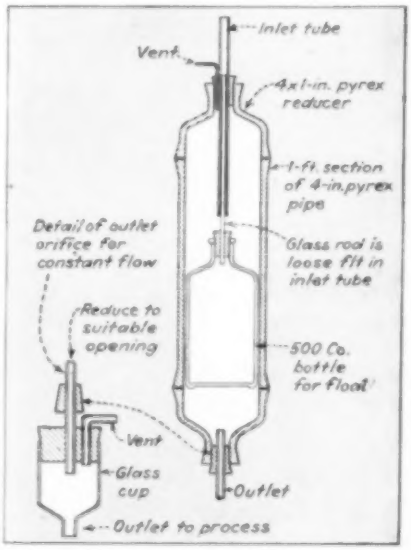


Fig. 2—Constant level controller with constant flow orifice

in the outlet line. Adjustment of the head, and therefore the flow, may be obtained by raising or lowering the acid inlet tube.

Either the pneumatic or electric valve, will perform better if the constant level controller is installed between it and the acid supply tank. For a flow of 0 to 50 c.c. per min. through a ¼-in. I.D. rubber tubing, a head of 6 to 8 in. was found satisfactory.

In actual operation, the pneumatic valve gave better pH control than the electric one, which was set up on a similar system. This is largely because the speed of response of the control instrument used with the electric valve was not quite adequate for the application.

A wider range of speeds was available in the pneumatic instrument, so that it was found possible to select a suitable speed. It was easily possible to hold the pH of a well mixed 200-gal. tank of poorly buffered solution within ± 0.5 pH units regardless of varying conditions in the remainder of the system. When external conditions were stable, regulation within ± 0.1 pH units was frequently obtained.

CONTINUOUS MEASURING OF SOLUBLE SOLIDS

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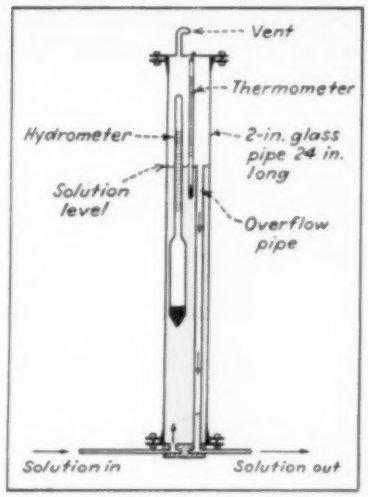
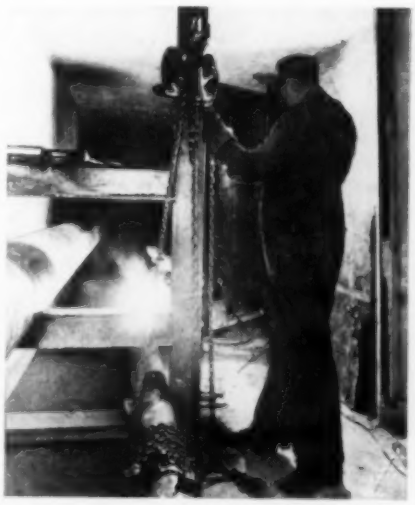
ONE OF THE liquid streams in a food processing plant was an aqueous solution of certain soluble solids. It was important to the quality of the product that the concentration of these solids be kept as uniform as possible. However, the only method for determining the solids content consisted in an analyst's weighing a sample of the solution, evaporating it to dryness, weighing the residue, and calculating the results. Aside from the fact that these hourly samples took a lot of an analyst's time, 8 to 12 hours was required to evaporate the sample to dryness. Another disadvantage was the fact that analysts were available only during the daytime, and results of samples were often not reported for 24 hours or more. By this time it was too late to make the necessary corrections, and proper control was impossible.

To solve this problem, the densities of several solutions of known solids content were determined at various temperature on a Westphal balance. Temperature was plotted against density, and lines of constant soluble solids content drawn. These were essentially straight lines on ordinary graph paper, and parallel lines were drawn for each 0.5 percent of solids. Accurate hydrometers and thermometers were supplied to the plant operators together with a photostatic copy of the conversion chart. In this manner the plant operators were able to determine the soluble solids content to within 0.5 percent in a very few minutes.

Unfortunately, a high rate of breakage of hydrometers and thermometers sometimes delayed the determinations. To combat this, a continuous measuring device was assembled from glass pipe and metal fittings as shown in the sketch, and a small side stream of solution was made to flow through it at all times. This simple instrument containing a hydrometer and thermometer was mounted on the wall together with a framed copy of the conversion chart for quick reading. This device proved very effective, as it was no longer necessary to draw a sample of the solution but only to read the temperature and density and convert the readings to percentage solids. This total operation could be performed in two minutes, and the slight loss in accuracy was more than compensated for by the speed with which corrections to the solution concentrations could be made. Direct savings included not only the analysts' and operator's time, but also an appreciable amount of solution previously lost by repeated sampling.



Continuous flow device for density and temperature measurement



TO SPEED WELDING

This view, provided by the Air Reduction Sales Co., clearly shows how "roll welding" is accomplished, to allow the welder to work always in a flat or downhand position, thus speeding the work and assuring sound welds. A block and fall is rigged at each end of the 6-in. pipe. By unwinding at intervals the pipe is turned to keep the weld uppermost.

required for instrumentation, as experienced by other similar processes, can be helpful. A very limited but recent survey of the chemical process industries divulges the figures presented in Table III.

Comparative Costs

Instrumentation costs for the production of methanol intermediates, acetic acid recovery, polythene synthesis, manufacture of acrylic resin molding powder, and agricultural insecticide and fungicides, are reported by one user to vary from 8 to 12 percent of the investment in total installed equipment. Another user reports that the average instrumentation cost for ten units making agricultural chemicals and plastics is 9.7 percent. A progressive manufacturer of perfumes and cosmetics reports that instrument costs usually run between 5 and 10 percent, but that on some processes, instrument costs run as high as 19 percent. A textile manufacturer reports that the average mechanical operation in a textile mill, such as weaving and spinning, requires an investment in instrumentation of well under 1 percent of the total plant equipment investment. Large soap manufacturers report that instrumentation costs run between 2.2 and 3.2 percent of the total investment in equipment. On a more complicated plant, operated by a soap manufacturer, it is reported that the instrumentation costs are as high as 8.6 percent. A processor of non-ferrous ores and manufacturer of non-ferrous salts reports that instrumentation costs of an electrolytic refining unit are approximately 1.02 percent. A lime plant owned by this same processor has an investment of only 0.39 percent in instrumentation.

These wide variations in instrumentation cost percentages are a result of many factors as discussed in the following paragraphs.

Numerous factors determine the percentage of the total investment in a process which must be allotted to instrumentation. Some of these factors are: (1) Nature of unit operations making up process; (2) special items required because of corrosion, low flows, etc.; and (3) capacity versus number of processing units. The fact that some industries are more instrument-minded and conscious of the many advantages which continuous measurements and automatic controls bring about also has an important bearing on comparative costs. Petroleum refiners and manufacturers of organic chemicals are outstanding in their appreciation of instrumentation and hence they invest more capital in this direction. An important observation made over the past few years indicates that improvements and technical progress in processing go hand in hand with increased instrumentation.

Table III—Installed Costs of Instruments as Percentages of Total Process Equipment Costs

Process Type	Percent of Equipment Cost
Ethylene plants	4
Solvent dewaxing units	3
Thermofor catalytic cracking units	3.4
Viscose making	2.9
Synthetic ammonia plants	3.2
Contact sulphuric acid plants	3
Nitric acid plants	2
Hydrochloric acid plants	1.9
Superphosphate plants	Negligible
Hydrofluoric acid alkylation units	5.7
Gas recovery units	4.9
Styrene plants	4
Pharmaceutical plants	15
Soap plants	2 to 3.2
Electrolytic non-ferrous metal refining	0.91
Lime plants	0.45
Manufacture of fluoride salts	1.1
Pulp mills	3
Textile mills	1.5

Nature of Operations

Processes involving distillation are well known as heavy users of instruments. One fractionating tower, for example, may require a potentiometer to control column temperature by resetting the control index of a flow controller on the steam supply line to the reboiler, a flow controller on the tower feed, a liquid level controller on the tower bottoms, a flow controller on the reflux line, a liquid level controller on the reflux accumulator, and integrating flow meters on the product lines.

On the other hand, mixing, crushing, grinding, and filtering are operations which usually require only the simplest type of instrumentation. A superphosphate plant which involves principally crushing, grinding, leaching, mixing, and packing involves practically no instrumentation. Reflection on the figures given in Table III will bear out these conclusions.

Some operations require that more variables be controlled and more facts be known than others. Logically, where temperature, pressure, pH, or other variables must be controlled within very narrow limits, the best in available instrumentation will be required. Where costs of steam and other media are extremely pertinent, numerous recording and indicating meters may be required.

It is not unusual for 50 percent of the total investment in a pilot plant to be devoted to instruments and controls. Here temperatures and pressures and other variables are measured and recorded at a host of locations which normally would not be of interest in a large operating unit—once it is developed.

Where corrosive materials are handled, equipment costs in general rise. Instruments and controls are no exception. The figure of 5.7 percent for hydrofluoric acid alkylation given in Table III, as compared with the other typical petroleum processes listed, is due in large part to special valves, protection for sensing elements, etc. Where small flows which cannot be handled in the smallest conventional control valves are encountered, more expensive valves of special construction must be used, upping the total instrumentation costs.

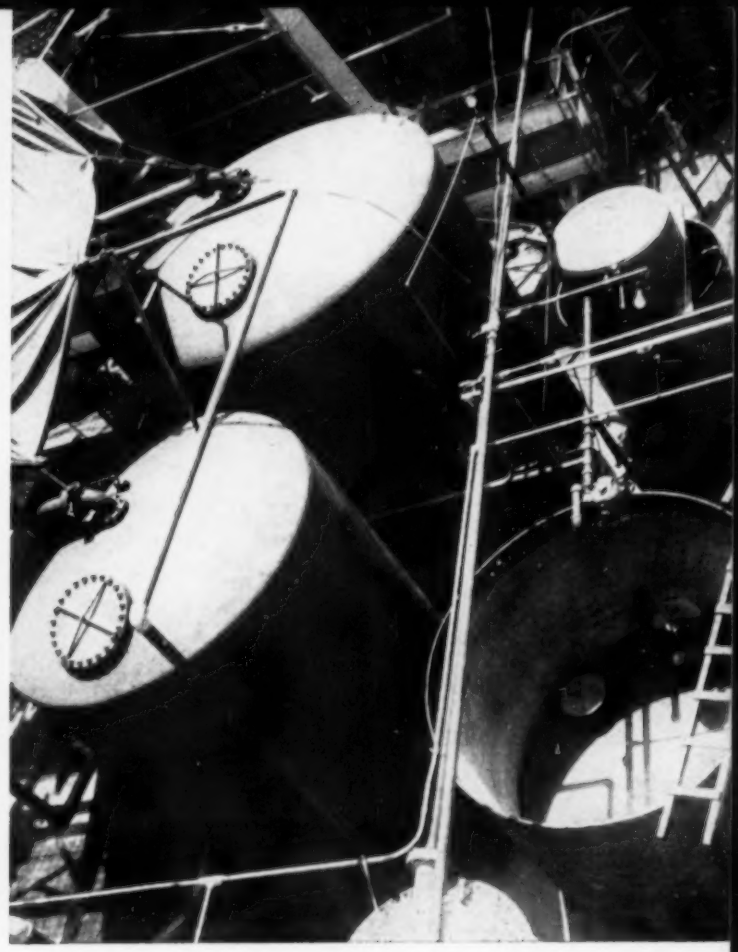
Although the capacity of one unit making a given substance may be three times the capacity of another unit making the same substance, the number of critical process variables which must be measured or controlled remains about the same. For example, about 4 percent of the investment in a 20-ton capacity contact sulphuric acid plant is for instrumentation. A 200-ton capacity plant requires only 2 percent investment in instrumentation. In increasing the capacity of a unit, the major increase in instrumentation costs is brought about by the greater cost for larger control valves, longer lengths of extension wire, connecting tubing, etc., and is not markedly affected by requirements for a larger number of individual instruments.

Summary

The author of this article humbly acknowledges that it represents a mere scratch on the surface in so far as a complete instrumentation cost study is concerned. However, it is sincerely hoped that readers of this article will pass on to the editors of *Chemical Engineering* ideas as to how the subject should be approached when attacked on a grander basis. Users of instruments are especially urged to submit pertinent instrumentation cost data when called upon to do so in the future as this study makes further progress.

In conclusion, grateful asknowledgement is made for the valuable assistance rendered by the engineering departments of several equipment manufacturers, as well as refinery and process plant operators and the personnel in several departments of the author's own company.

FROM SMALL packaged units . . . . . .



TO LARGE engineered installations

"Chem & Met" REPORT ON . . . . .

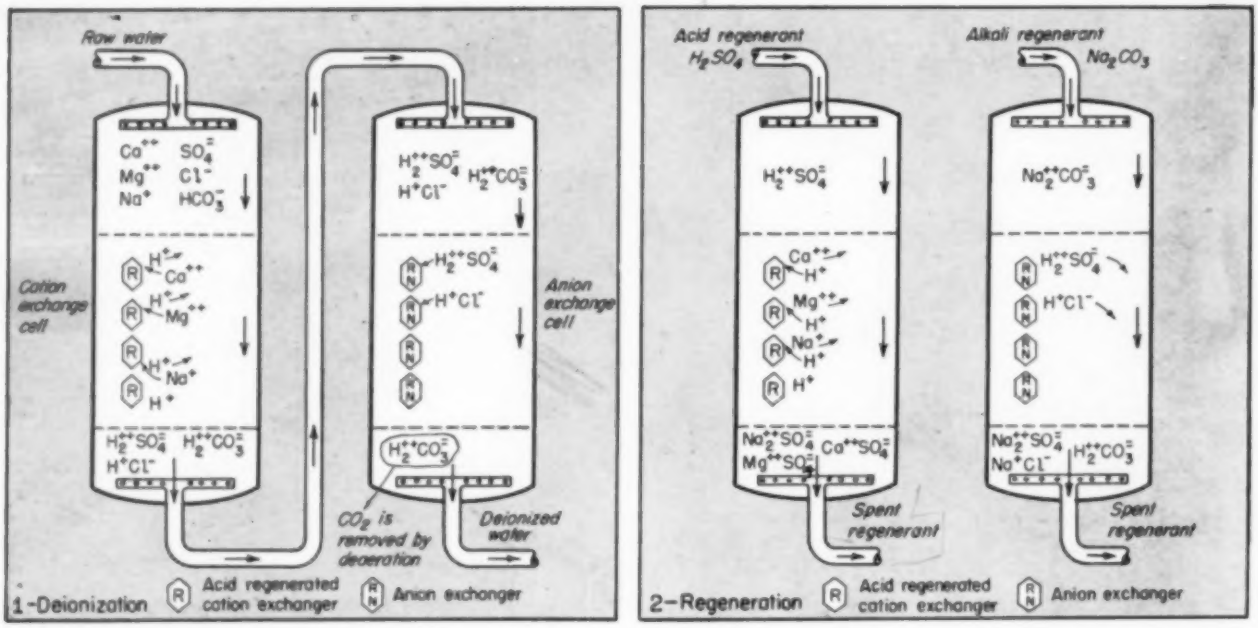
ION EXCHANGE

Principles Technology Applications

Ion exchange is not new either in principle or in application. But its importance to the process industries is increasing. Based on techniques used for years in water treating, its scope was broadened significantly by the development of synthetic organic ion exchangers. Already used commercially for a number of purposes, ion exchange is being currently studied and investigated in countless laboratories and pilot plants throughout industry.

KNOWN in principle for a century and used industrially for some 40 years in the softening of water, ion exchange has only in the past ten years become important for non-water uses. Although these applications are relatively new, ion exchange has captured the interest of many chemical engineers who have found it a useful tool in a wide variety of processes.

Taking the spotlight now are the sugar and related industries where a dozen or more pilot plants have been



PRINCIPLES of ion exchange remain the same but new ways to apply them are constantly being developed

operated and where commercial units costing nearly a million dollars each are under construction. Here the increased yields of sugar and the improved quality of residual molasses have seemed to justify the major investment required.

On the other hand, less spectacular processes should not be overlooked. Water treating is still the largest user of ion exchange. Demineralized water, the chemical equivalent of distilled water can be produced at a fraction of the cost of distilled water. The versatility and flexibility of ion exchange has made it possible to deionize water on a scale and for purposes heretofore impractical. Demineralizing plants have been installed in capacities ranging from a few gallons to over 40,000,000 gal. per day.

Principles

Key to this development was the discovery, in the mid 1930's, that various types of organic materials possessed ion exchange properties. Up to that time only the siliceous zeolites were used, permitting base exchange between metallic cations only. The advent of organic cation exchangers made possible the exchange of hydrogen ions and led to the development of acid adsorbent resins. Thus, complete deionization of solutions became a commercial reality and opened the door to a whole new field of ion exchange applications.

Ion exchange may be defined as the reversible interchange of ions between a liquid and a solid involving no appreciable change in the structure of the solid. There are two types of ion exchange, (1) cation exchange, where the positive ions in solution are exchanged for the positive ions of an insoluble matrix, and (2) anion exchange in which the negative ions in solution exchange with the negative ions of an insoluble solid or where acids in solution are adsorbed in an insoluble form on the solid. Reversability of this reaction makes it possible to restore the original ions of the exchange material after its activity has been exhausted. This regenerability permits the exchange material to be used and reused through innumerable cycles.

The mechanism of ion exchange can be illustrated by a few simple reactions. Cation exchange may be carried out in the so-called sodium or salt cycle and in the hydrogen cycle. In the salt cycle metallic ions in solution are replaced by the metallic ion of the exchanger (most commonly used in water softening where Ca and Mg ions are replaced by sodium):

$$2\ NaR + CaSO_4 \rightleftarrows CaR_2 + Na_2SO_4$$

where R is the cation exchanger.

The exhausted exchanger is regenerated with common salt:

$$CaR_2 + 2\ NaCl \quad 2\ NaR + CaCl_2$$

In the hydrogen cycle, however, cations in solution are replaced by the hydrogen ion of the exchanger, forming an acid in the effluent:

$$HR + NaCl \rightleftarrows NaR + HCl.$$

Acid regeneration is usually accomplished with sulphuric acid:

$$2\ NaR + H_2SO_4 \rightleftarrows 2\ HR + Na_2SO_4:$$

Although the exact nature of anion exchange is not fully understood, it appears to take place as an addition reaction in which the whole acid molecule is adsorbed. Acids may thus be removed from solution:

$$RN + HCl \rightleftarrows RN\ HCl$$

where RN is the anion exchange resin. True ion exchange may take place between the anion of an acid exhausted resin and another acid as follows:

$$2\ RN\ HCl + H_2SO_4 \rightleftarrows (RN)_2H_2SO_4 + 2\ HCl$$

The anion exchanger may be regenerated with an alkali such as soda ash, caustic soda, or ammonia.

$$(RN)_2H_2SO_4 + 2\ NH_4OH \rightleftarrows 2\ RN + (NH_4)_2SO_4 + 2\ H_2O$$

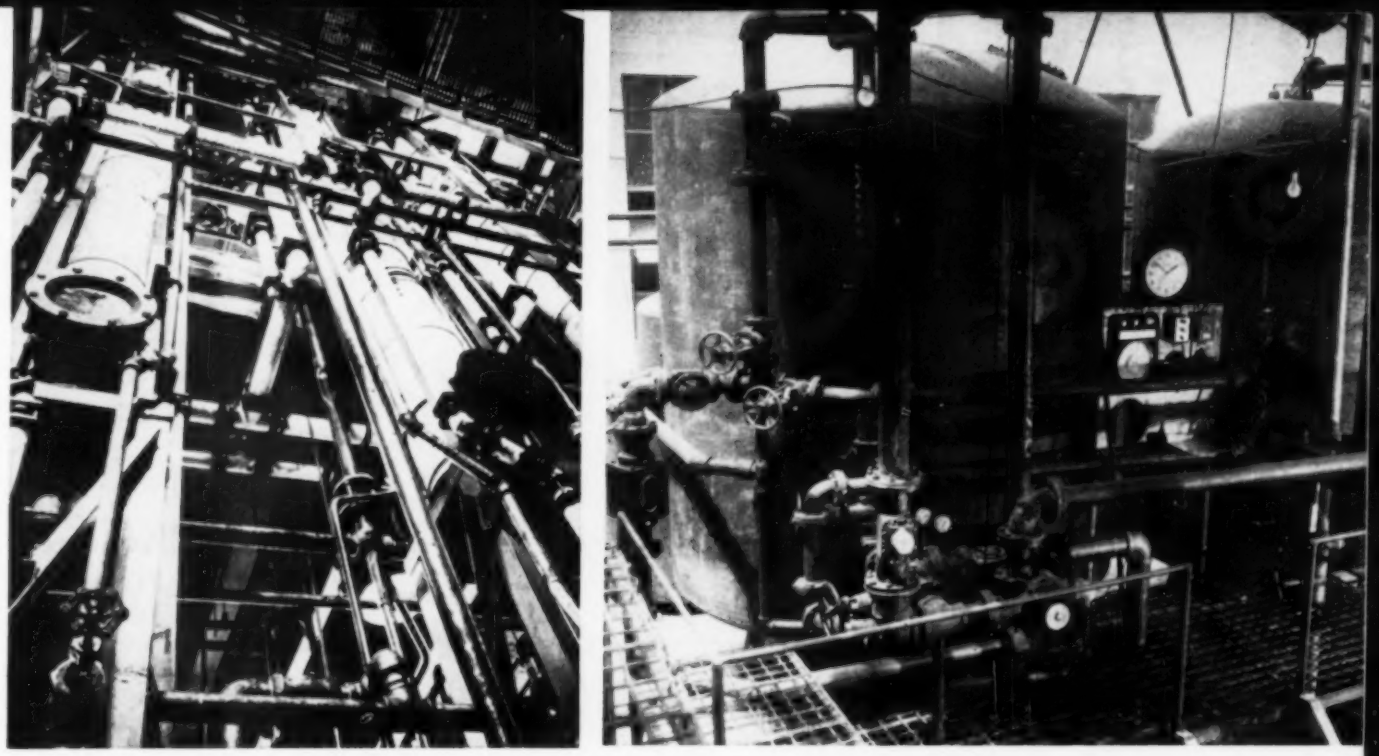
Since these reactions are governed by the law of mass action an increase in concentration of products affects the completeness of reaction. For this reason an excess of regenerant is usually used so that regeneration of the exchanger will be essentially complete.

Exchange or adsorption of different ions depends on a number of factors. In general, divalent ions hold to the exchanger more firmly than univalent ions and trivalent ions will usually displace the divalent ones. Ions of the same valency but of higher atomic weight are held in preference to those of lower atomic weight.

Exchange Materials

There are two general classes of commercially used ion exchange materials, namely, inorganic and organic. Inorganic cation exchangers are complex aluminum silicates known as zeolites widely used for water softening.

Most important in today's ion exchange operations are the organic exchangers. These fall in two classes,



DESIGN of equipment may vary from tall porcelain columns to rubber-lined steel tanks, depending on the process

(1) the "carbonaceous zeolites" which are cation exchangers obtained by the sulfonation of coal or other natural organic materials and (2) synthetic resins for both cation and anion exchange. Cation exchange resins are phenol-formaldehyde, sulfonic acid derivitives while anion exchangers are amine derivatives of either aromatic or aliphatic resins. The cation exchangers utilize ion active groups such as $-SO_3H$, $-COOH$, $-OH$ and $-CH_2SO_3H$ while all anion exchangers depend on the $-NH_2$ group.

Organic cation exchangers may be regenerated with acid to operate in the hydrogen cycle or they can be regenerated with salt to operate in the sodium cycle. From the standpoint of physical structure ion exchangers are extremely insoluble porous materials whose walls contain a high percentage of tightly bound exchange groups. In appearance they are granular solids in sizes ranging from 10 to 70 mesh and may vary in color from white to black. Densities of organic exchangers as shipped may range from 30 to 50 lb. per cu. ft. At least one resin manufacturer furnishes a cation exchanger in the form of spherical particles from 12 to 40 mesh.

Although exchange capacity is usually stressed, a number of other factors are just as important in evaluating these materials. Some of these include (1) degree of removal of ions from solution, (2) chemical requirements for regeneration, (3) flow rates or throughput and, most important, (4) chemical and physical stability.

Perhaps the most important point relating to synthetic ion exchangers is the possibility of varying the properties by varying the synthesis of the resin. Thus we may develop ion exchange resins for specific purposes.

While a great deal of research is being carried out by the resin manufacturers, one most interesting development in this field is a cation exchanger based on an aromatic hydrocarbon polymer (polystyrene type) containing nuclear sulfonic acid groups. This material is claimed to have good stability to strong alkalies, strong oxidizing agents, and to higher than normal temperatures.

In general, ion exchange is carried out at relatively low temperatures. One manufacturer recommends that cation exchangers be used at temperatures below 140 deg. F. and anion exchangers below 110 deg. F. Considerable experimental work has been done on higher temperature operations but nothing conclusive has yet been determined.

Since ion exchange involves reaction between a liquid and a solid, the primary function of any equipment used for this purpose is to bring the reaction components into intimate contact so that exchange of ions may take place. While this may be accomplished in a number of different ways, the most common method is to pass the liquid through a bed of ion exchange granules.

Manufacturers of Synthetic Resins and Ion Exchange Equipment*

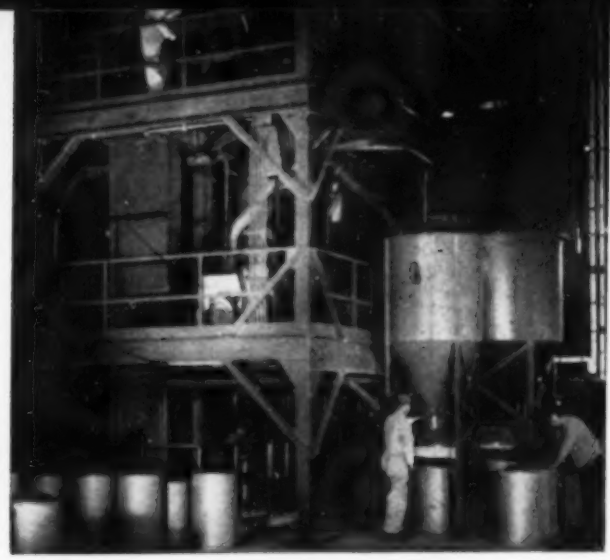
	Resins		Equipment
	Cation	Anion	
American Cyanimid Co.	X	X	X
Chemical Process Co.	X	X	
Cochrane Corp.			X
Dorr Co.			X
Dow Chemical Co.	X		
Illinois Water Treatment Co.			X
Infilco Corp.			X
Liquid Conditioning Corp.			X
Permutit Co.	X	X	X
Resinous Products & Chemical Co.	X	X	

* This list is not complete, especially with regard to equipment manufacturers. However, it represents the major companies involved in industrial ion exchange work. Some of the resin manufacturers do not market their own products, for instance, Dow Chemical Co. markets its resins through the National Aluminate Co. and Chemical Process Co., for the most part, markets its resins through the equipment suppliers.

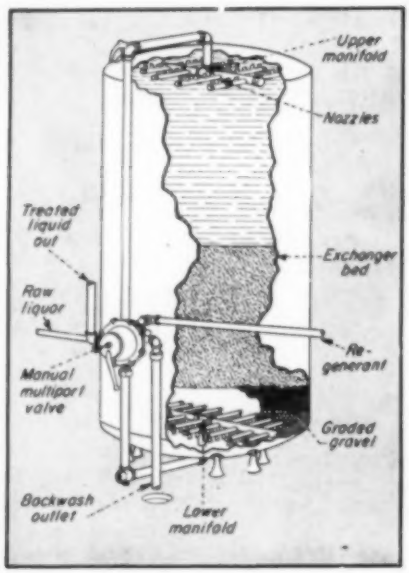
Equipment

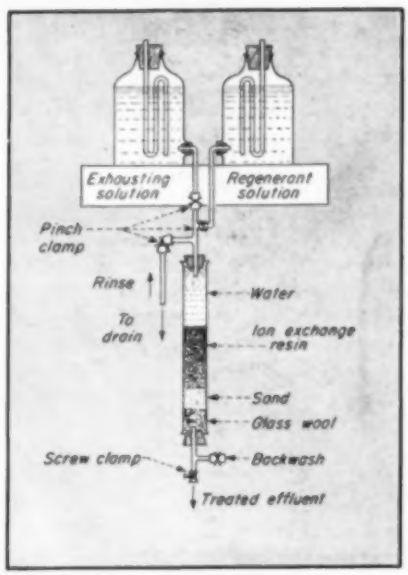
Normal operating cycle is comprised of four steps as follows: (1) reaction between exchange bed and raw liquor, (2) backwash of the bed to remove dirt, foreign matter and to loosen and regrade bed, (3) regeneration of exhausted exchanger by passing regenerant solution through the bed, and (4) rinsing the bed free of regenerant. The bed is then ready for the next cycle. To insure continuous flow of liquor, three units are usually provided. At a given time one unit is on stream, one is being regenerated and one is ready for operation.

All equipment is of more or less standard design. Each unit, either for cation or anion exchange, consists of a cylindrical tank or column containing a bed of ion exchanger supported on a false bottom or on built up layers of graded gravel, quartz, or similar material. A collector device is built under the false bottom while a system for distributing the raw liquor and the regenerant is installed above the exchanger bed. An external piping sys-

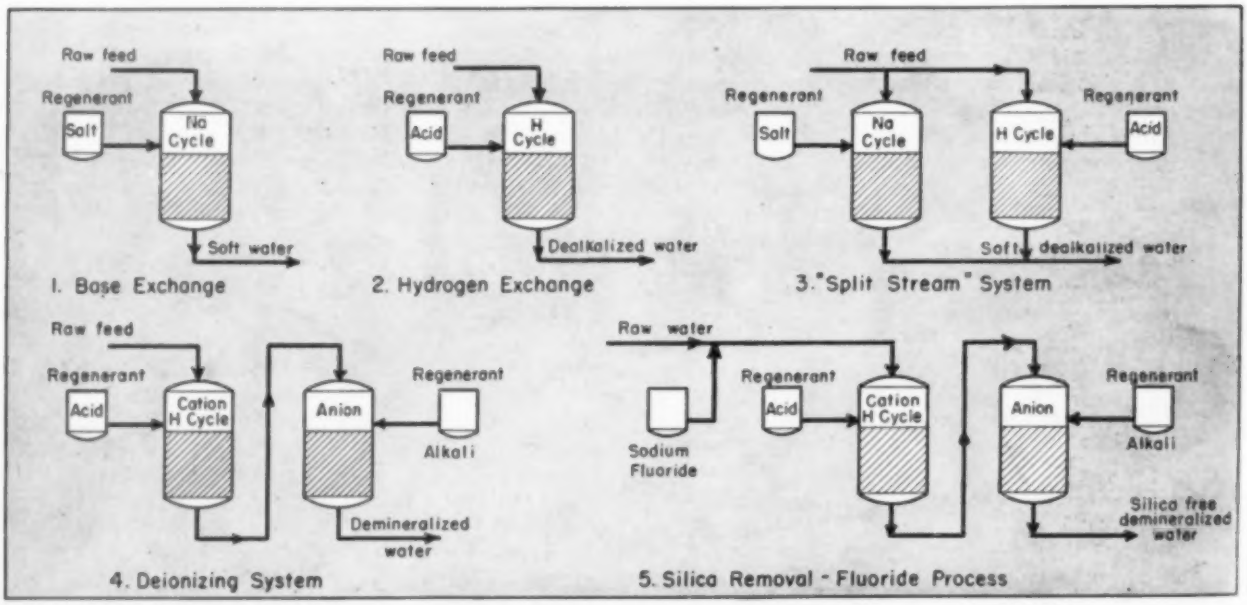


MATERIALS—Synthetic resins can be "tailor-made" to provide specific properties for special types of applications





EQUIPMENT—Simple filter bed design is universally used for both commercial type units and laboratory test cells



HOOKUPS—Five basic hookups used in treating water represent the bulk of all ion exchange installations

tem handles the flow of liquor, regenerant solution, backwash and rinse water.

One of the most critical factors is the design of the distributing system because the liquor must pass through the bed without channeling. Uniform and efficient distribution of the liquor, regenerant solution, backwash and rinsewater is essential for economical and satisfactory operation. Perforated piping such as spiders, circular sparge pipes and laterals are used for both distribution and collection. The supporting bed prevents the fine granules of exchange material from passing out with the effluent. It also aids distribution of the backwash.

Either upflow or downflow of liquor through the bed may be practiced but downflow is most common. Flow rates are more critical on upflow operation since they must be low enough to prevent carryover of material and high enough to partially suspend the bed to prevent channeling.

Flow of liquor through the exchanger may be by force of gravity or under pressure. Open tanks may be used for gravity operation but where contamination of the solution might occur these are not desirable. Pressure operation, more generally used than gravity, requires use of closed vessels.

Automatic Control

Because of the cyclic nature of the operation the external piping and valve system is necessarily quite complicated. Manual operation of valves is practiced on many applications where the cycles are relatively long but there is a definite trend toward greater use of automatic and semi-automatic control. Advantages of automatic control are well recognized but in operations such as this, especially on complete demineralization systems, they are quite pronounced. Labor savings, more uniform operation and, most important, reduction of the chances for manual manipulation of the wrong valves are well worth the expense of a control system.

Multiport valves and pilot operated diaphragm valves are widely used. The operation in the cycle may be properly controlled in sequence by a timer, volume measurement or by pH or conductivity measuring devices. Many of the modern demineralizing plants are being equipped with complete automatic control.

Since deionization equipment has been built for capacities ranging from a few gallons up to millions of gallons per day, it is obvious that the size and number of units may vary widely. Individual cells up to 24 ft. dia. have been installed but most units are below 12 ft. dia. to avoid the necessity for field fabrication.

Depth of the exchange bed is determined by the quantity and nature of the ions to be removed and the length of operating cycle desired. Seldom is bed depth under 30 in. For non water applications especially, bed depth is usually greater than this. From 50 to 100 percent freebroad or rising space is provided above the exchanger bed. During backwashing the bed is suspended by the upflow of wash water and adequate space must be provided so that the exchanger doesn't carry over with the wash liquor. Siliceous exchangers, having a high specific gravity, require only about 50 percent freebroad while resinous materials, especially the low specific gravity anion exchangers, require a space equal to the original bed volume.

Size and Capacity

Because of practical limits to size of individual units, large capacities are usually handled by multiple units. Where desired throughput is large and mineral content is low (as in some water demineralization) it is possible to run a number of units in parallel. On the other hand, where mineral content is high, the bed depth reaches practical limits and it is necessary to run two units or more in series.

Materials of construction are important. Practically all equipment, other than that used in water softening, must be able to withstand corrosion. Where demineralization, hydrogen ion exchange, or anion exchange takes place, rubber lined steel equipment is used. For gravity flow units wood tanks with rubber lined steel pipe and fittings are often used.

It is the need for periodically regenerating the exchanger bed that has provided ion exchange operation with its biggest disadvantage. Although continuous throughput of liquor is accomplished by use of multiple beds so that one or more may be operating while others are regenerating, this system requires large floor space, many units and an excessive amount of piping, valves and control equipment. Efforts are being made to develop this into a continuous operation but so far nothing has found its way outside the development laboratories.

First commercial ion exchange application used siliceous zeolites to remove Ca and Mg (hardness) from water. This is still widely used but both carbonaceous zeolites and synthetic resins, with their superior qualities of higher capacity and greater pH range, are capable of better performance and their use is growing rapidly. Where softening alone is desired, the cation exchanger is operated in the sodium cycle. The bed is regenerated with salt. Here the total solids in the water is not reduced and the water still reacts alkaline.

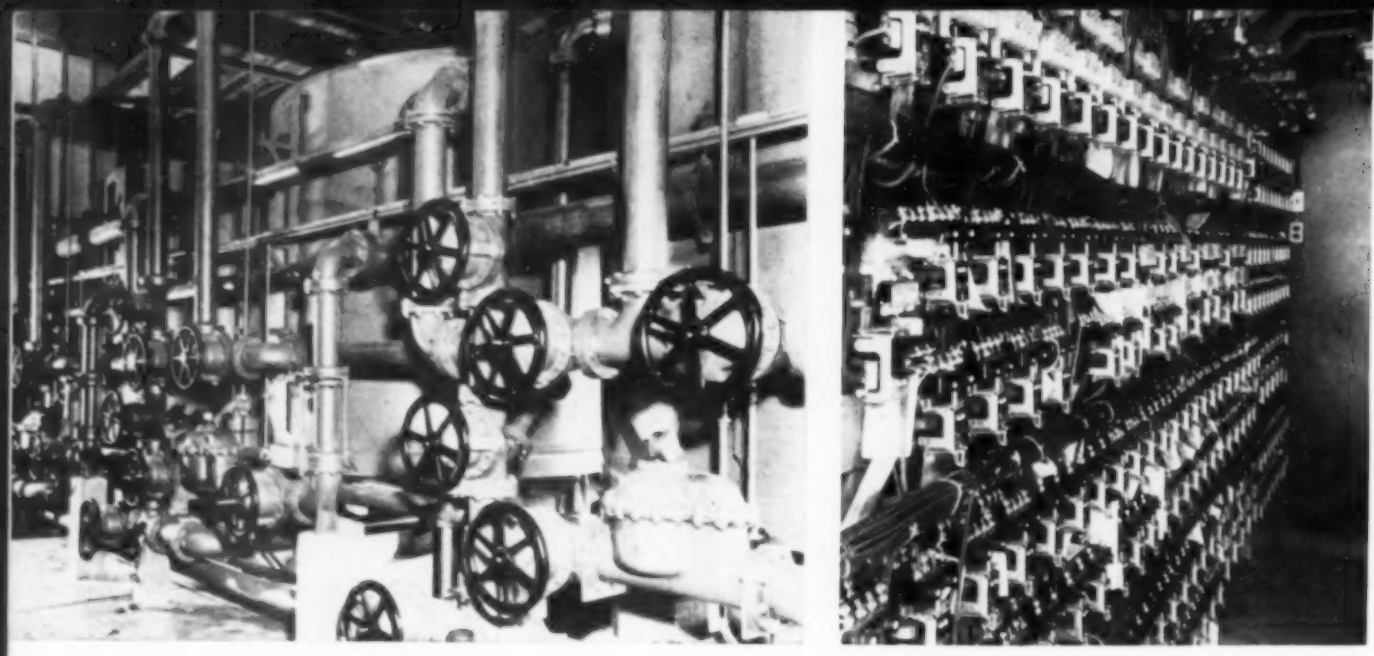
Water Treating

Operating in the hydrogen cycle, an acid regenerated cation exchanger removes Ca, Mg, Na, Fe while converting the chlorides, sulphates, nitrates and carbonates to their acid derivatives. Effluent then is acid to the extent of the hydrogen ions required to replace the metallic ions. Acids thus formed can be neutralized sufficiently by (1) blending with raw water, (2) by the so-called "split stream" method of blending with water softened in the sodium cycle or (3) by removing the acids in an anion exchange cell. In any case it is necessary to remove the CO_2 (from the carbonic acid) in a degasifier.

Blending raw water with the effluent from the hydrogen cycle cation exchanger provides a reduced alkalinity water which contains some hardness. The split stream system results in a neutral completely softened water. Complete demineralization, however, produces a water that is the chemical equivalent of distilled water. Where water of this quality is required, demineralization is invaluable. While more and more industries are finding it desirable to use better process water, demineralization has already become established in many fields such as fine chemicals, pharmaceuticals, beverages, dyes and others.

Cost of deionized water is markedly less than for distilled water. Distillation units operate at a more or less fixed cost per gallon regardless of the quality of the feed. On the other hand the cost of demineralizing varies with the amount of material to be removed. Depending on the quality, water can be demineralized from a few cents to 25 or 30 cents per 1,000 gal., depending on the mineral content. This is but a fraction of the cost of distillation.

Most significant development in water treatment is the removal of silica by ion exchange. Silica content of most water is low and except in boiler feed water is of little significance. Ordinary deionization processes do not affect silica because it is practically non ionized. To accomplish silica removal by deionization, sodium fluoride is added to the raw



CONTROL is accomplished by operating valves either manually or by automatic sequence selectors on a panel board

feed entering the cation exchanger where it is converted to hydrofluoric acid. This reacts immediately with the silica to form fluosilicic acid which is subsequently adsorbed by the anion resin. A final concentration of silica as low as 0.5 ppm SiO_2 can thus be accomplished. It is necessary to modify the ordinary backwash and regenerating procedure. The anion exchanger must be rinsed with acid to flush out residual fluosilicic acid before regenerating with caustic since the regenerating treatment would precipitate silica on the bed with subsequent clogging.

Cost of silica removal by this process are said to be higher than by the old conventional methods. Various modifications of this process may also be used. A number of plants are now under construction or are contemplated to provide silica free boiler feed water in capacities up to nearly 3,000,000 gal. per day.

Sugar

It is in the sugar industry that most intensive efforts have been made to utilize this new process tool. Millions of dollars are being spent for commercial and pilot size plants to remove impurities in the production of sugars and sirups from various sources. Higher sugar yield, elimination of low quality molasses, recovery of waste sugar, plus the possibility of eliminating costly process steps are in back of the current spending program.

Sugar refining is comprised of two main types of operations. The first is a series of steps which remove dissolved non-sugar solids and the second is to separate pure sugar from the remaining dissolved impurities by evaporation and crystallization. Success of the second step is dependent on the first since it is recognized that the major factor limiting the crystallization of sugar is the presence of non-sugar solids in solution.

With present standard methods of purifying sugar juice, both cane and beet (straight house) it is possible to obtain juice approximately 90 percent pure and to recover 83½ to 85 percent as pure sugar. However, with the ion exchange process it is possible to remove a greater proportion of these non sugars to produce a juice of 96½ to 98½ percent purity. This means that 95 percent or better of the total sugars can be recovered as white sugar. In addition the remaining molasses is an edible pleasant tasting sirup that can be marketed as such. Important from the operating standpoint, the removal of substances such as calcium, improves heat transfer by eliminating scaling of equipment.

Although the primary purpose of deionization is to remove mineral electrolytes it had been found that this treatment can remove from 60 to 90 percent of the organic non-sugar solids. Colloidal material and various other substances which affect taste, odor and color are removed to some extent. There is a strong possibility that some of these non sugar fractions of the sugar juice, such as amino acids, which become concentrated on the exchange resin can be recovered from the spent regenerant solution.

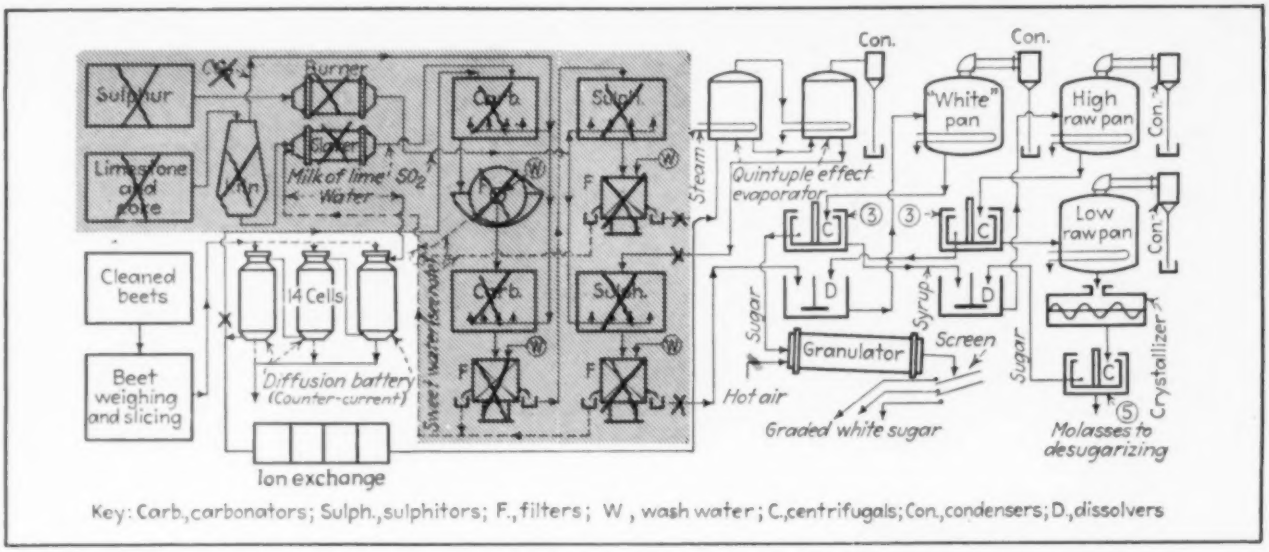
Increased yields and improved quality sirups, during the period of sugar shortage, have been incentive enough for the sugar industry to develop this new refining technique. But in the long run, the real value of ion exchange will be in doing a better job cheaper. This can be accomplished only by supplanting and eliminating some of the present process steps.

Most activity now is in beet sugar. Ion exchange units have been used to treat the juice at various points in the refining process. Most desirable, economically, would be to deionize diffusion juice directly and then pass it to the evaporators. This would eliminate the carbonation and sulphitation steps and would save materials and labor. Use of ion exchange should eliminate the need for Steffens house treatment wherein sugar is recovered from straight house molasses. However, in the face of all this work, additional Steffens house facilities are still being planned.

Although several commercial ion exchange plants are being engineered and built for beet sugar, one such plant consists of four cation and four anion exchange cells each 12 ft. in diameter by 12 ft. deep. Resin bed depth is 5 ft. Tanks, piping, valves, etc. are rubber lined to protect them against corrosion. Automatic hydraulic diaphram valves are operated by sequence selectors on a panel board so that the operator need only push a button and the proper valves on the selected units will position themselves. Recording conductivity and pH meters determine when the units reach exhaustion.

Only one pair of cells is on-stream at a given time while the other three units are in various stages of regeneration or in standby condition. Downflow operations under pressures up to 15 lbs. are practiced. Sulphuric acid and ammonia are used for regeneration and facilities are available for bulk storage of tank car lots.

Basic technology of deionizing sugar solutions and water is the same. But



PROFITS in beet sugar will come from substituting deionization for present standard methods of juice purification

here the similarity ends. Dissolved solids in water seldom exceed 7.0 milliequivalents per liter but the impurities in sugar beet juice after carbonation run from 35 to 75 milliequivalents per liter and raw juice from 80 to 100. Thus, while it is not uncommon to deionize 500 to 2,000 gal. of water per cycle per cu. ft. of each ion exchanger, it is only possible to treat 50 to 150 gal. of sugar juice under the same conditions due to the high concentration of impurities. Obviously, then, for a given throughput, sugar juice treatment requires larger equipment and shorter cycles than does water. In general, the cycles followed in sugar with four pairs of cells is ½ to 1 hr. on-stream and 1½ to 2 hr. for washing and regeneration.

Since all sugar solutions must be concentrated by evaporation, it is necessary to prevent undue dilution. When the exchange cells go on-stream the voids between the resin particles of the bed are filled with water. About 70 percent of this is displaced by a piston-like action and contains no sugar. The remaining 30 percent mixes with the sugar juice but since it is quite dilute, it is returned as sweet water for reprocessing. This part of the cycle is known as "sweetening on". Upon exhaustion when the units are taken off stream, they are sweetened-off in a similar manner.

It is also necessary to take into account the water or juice in the space above the bed. Various arrangements of liquid level control may be used to keep this volume to a minimum to decrease dilution and to lower the rinse water requirements.

Another factor which complicates the process and adds to the cost is that of removing proteins, gums, and various nitrogenous tarry materials which adhere to the surface of the resins. When ordinary backwashing fails to remove these it sometimes is necessary to apply a caustic backwash. Where resins are not adversely affected, it may be possible to backwash with hot water.

Of great concern to the manufacturers of crystalline sugar but of no importance to the liquid sugar or sirup producers is the tendency toward excessive inversion. Acid conditions of the cation cell are principally to blame for decreasing the sucrose content by inversion. One way to minimize this is to operate the process at high throughput rates to lower the time that the solution is in the acid condition. As soon as it reaches the anion cell the acid is removed and no further inversion will occur. A disadvantage of operating two or more pairs of cells in series is the fact that the increased time under acid conditions adds to the inversion loss. While normal operating temperatures are below 25 deg. C., lowering the temperature even further helps to minimize inversion.

Operating Costs

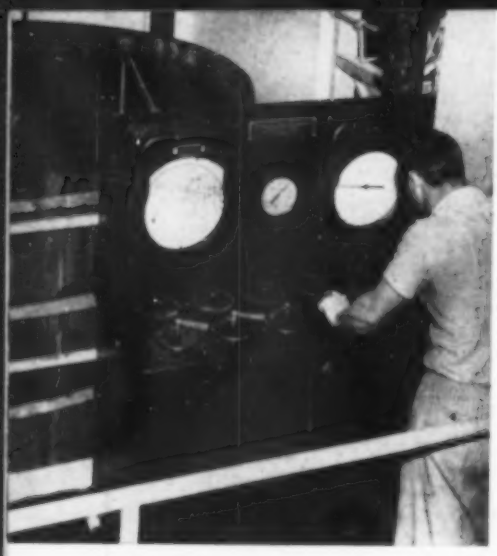
Major operating cost is for regenerants. Generally, 15 to 25 lb. of 66 deg. Bé sulphuric acid per ton of beets are required while about 5 lb. of anhydrous ammonia per ton of beets are needed to regenerate the anion exchanger. For a plant processing 2,000 tons of beets per day over a campaign of 100 days this would run to 500 tons of anhydrous ammonia and 2,500 tons of sulphuric acid. Now if ten such plants turned over to using ion exchange the need for sulphuric acid would jump to 25,000 tons and ammonia to 5,000 tons, a total consumption of 30,000 tons.

Sulphuric acid is used in preference to hydrochloric or nitric because of price. One difficulty with this is that when the cation exchange resin contains a large quantity of calcium ions, they react with the acid to precipitate calcium sulphate, which is sometimes hard to rinse off. When this occurs it is desirable to wash with a salt solution to remove the calcium before regenerating with sulphuric acid.

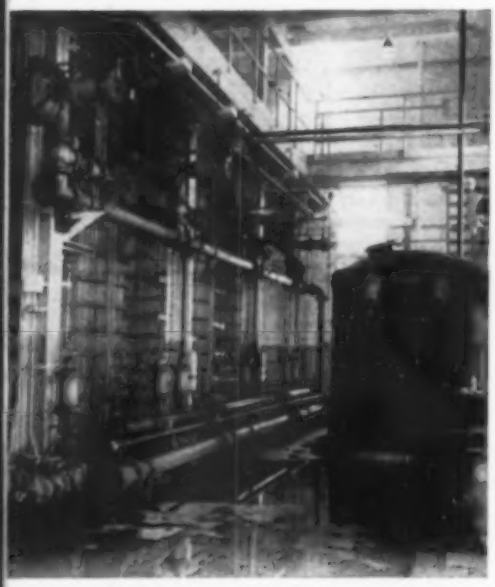
Although caustic soda, soda ash or ammonia may be used for regenerating the anion exchanger, the use of ammonia is often preferred because it rinses out more easily and is slightly cheaper to use.

Since it takes about 1 cu. ft. of each exchange resin per ton of daily capacity the total resin charge would be about 2,000 cu. ft. each or a total of 4,000 cu. ft. Due to operation losses, such as attrition, which run up to 15 percent per campaign, of 1,000 cycles, it is necessary to supply about 300 cu. ft. of each resin at the end of the campaign to make up for these losses.

Ion exchange treatment is substantially the same for refining cane, beet, fruit or corn sugar except that in the production of sirups and corn sugar products it isn't necessary to take precautions against inversion. Work is under way to recover more than 4,000 tons of sirup annually from unpotable pineapple juice in Hawaii. Similarly a plant is operating in Florida to recover sirup from waste citrus peel press juice. In both of



WATER from the lower Delaware River is demineralized in a gravity system



Cation exchangers on top floor discharge to anion units on floor below

Carbon dioxide in the effluent is removed by the degassifier on the right

these operations, citric acid is produced and a number of organic by-products may well be recovered.

Variety of Uses

Although water and sugar account for most of the large scale deionization units, there are many applications which demonstrate the wide range of usefulness of this process. Many of these, however, have not been publicized nor is it possible to obtain much information about them. Very often the user of a process develops his own application, builds his own equipment and purchases the necessary resins. While little can be told about these processes, a mere listing would serve to point up the versatility of this process.

Removal of formic acid from formaldehyde has gained in importance due to the requirements for an acid free material used in synthetic resin manufacture. By use of an acid adsorbent resin the formic acid is removed without adding objectionable salts to the formaldehyde. This permits higher catalytic reaction rates to improve yields of formaldehyde by removing the corresponding increased amount of formic acid.

Still not completely understood is deionization to achieve artificial ageing of whiskey. Green whiskey is passed first through a deionizing unit and then through a bed of activated carbon. Dissolved salts, free acids and some colloidal material are removed to achieve improvements in taste and odor. This application was made so recently that its value has not yet been fully established.

Outstanding example of recovering metals from dilute solution was carried out commercially in Germany for recovering copper from cuprammonium textile wastes. This recovery process was operated on a large scale using a cation exchange resin to adsorb the copper ammonium complex ion which, after regeneration, is processed to copper sulphate and is reused in the process. A large scale operation, one plant is comprised of ten cation exchange units approximately 10 ft. in dia. having a bed depth of 14 ft. Throughput rates of nearly 15 gal. per min. per sq. ft. were mentioned in contrast to about 6 gal. per min. per sq. ft. as practiced here.

Only one plant in this country employs the cuprammonium process for spinning rayon. Copper recovery is now being studied on a pilot scale.

Used extensively by pharmaceutical and fine chemical manufacturers, ion exchange has a part in a number of processes other than supplying demineralized water. One such application is in the production of streptomycin where it is necessary to neutralize without adding further salts to the solution. This is accomplished by acid adsorption in a unit containing anion exchange resin. In a subsequent step in this same process the streptomycin is converted from the sulphate salt to the hydrochloride.

Selective Adsorption

A subject of intensive study and research is the use of ion exchange resin as selective adsorbents in the separation and isolation of amino products. Preferential adsorption may take place due to specific properties of the resin and the ionized particles in solution. Differences of ionization strength will cause one ion to displace another. Thus it has been possible to develop methods to separate compounds which heretofore could not be readily accomplished.

Currently, the isolation of glutamic acid is being worked on extensively. Pilot plant operations have been successful and plans are underway to build a commercial unit. Already, other amino products such as lycine, histidine and argenine are being produced commercially by this means.

Although most research men consider the development of ion exchange process still in its infancy there are already many pilot plant and commercial size installations which provide a basis for even broader scale of applications. Some of these include recovery of alkaloids, removal of sulphuric acid from sulphonated oils, reduction of calcium content of milk for infant feeding, recovery of pectin from grapefruit peels, acid removal from dextrose, anion exchange to remove sulphuric acid from ethylene glycol, and in the processing of sorbitol.

Grateful acknowledgment is made to a number of individuals and firms whose help and cooperation made this report possible. Special appreciation is due the following: A. B. Mindler, Permutit Co.; B. N. Dickenson, Chemical Process Co.; J. C. Winters, Resinous Products and Chemical Co.; W. W. Jukkola, The Dorr Co.

Photographs were supplied by Permutit Co., American Cyanamid Co., Infilco Corp., and The Dorr Co.

MIXED FERTILIZER

MANUFACTURE of mixed fertilizer takes place in two major stages in a modern fertilizer works. First superphosphate is made by reacting ground phosphate rock with hot moderate-strength sulphuric acid to convert the tricalcium phosphate to dicalcium phosphate and to eliminate much of the fluoride. The resulting "green" superphosphate is cured by allowing it to remain for a period of days or weeks in piles. There further reaction takes place, free acid is eliminated, moisture is evaporated, and insoluble components reduced. During this curing period the gypsum which has been formed sets up so that the whole pile is a hard mass.

After curing, the superphosphate is broken down with a light explosive, transferred by power shovel and small power truck to the mixing department where it is ground and mixed with the other components of the formula being made, that is the nitrogen carriers, potash chemicals, and conditioners.

The combination is mixed, often with addition of ammoniating solutions, and transferred to the mixed goods storage. Slight further cure occurs there. But, if desired, the mixture can be shipped promptly either bagged or in bulk by railroad or highway trucks.

Mixing for storage or for bagging is accomplished with surprisingly simple handling through a succession of hoppers. Only in the case of first mixing with superphosphates does the fertilizer require special stirring or turning. The effectiveness of simple equipment is conclusively proved by frequent analyses of samples from single bags. Because of state inspection, great care must be taken to insure that every single bag meets formula requirements rigidly.

The operations here diagrammed take ground rock, acid, ammoniating solution, and dry chemicals (for nitrogen, potash, and conditioner supply) to form complete mixed fertilizer in bagged or bulk shipments ready for the farmer.

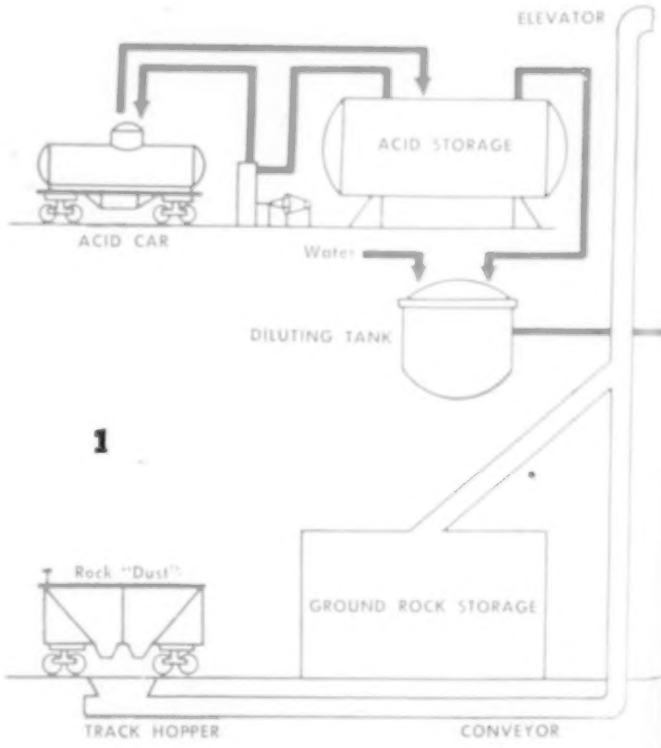
The process as practiced by International Minerals and Chemical Corp. at Hartsville, S. C., is here pictured. Further details of the Hartsville operation are presented in an article in this issue of *Chemical Engineering* on pages 92 to 95.

CHEMICAL ENGINEERING

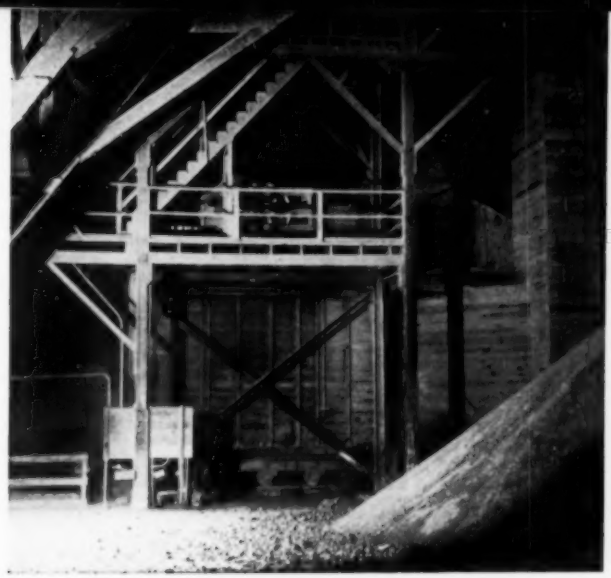
July, 1947

PAGES 132 TO 135

1 Raw materials are unloaded, acid from tank car and ground rock from special closed-top hopper-bottom cars. Photos by Hankins



2 Acidulating pan, with weight hopper and batch hopper for rock above and acid gage tank at left



3 Den, center; acidulating pan, above; rock storage, left, cutter housing and superphosphate elevator, right

5 Green superphospha carried to point on stora

PICTURED FLOWSHEET

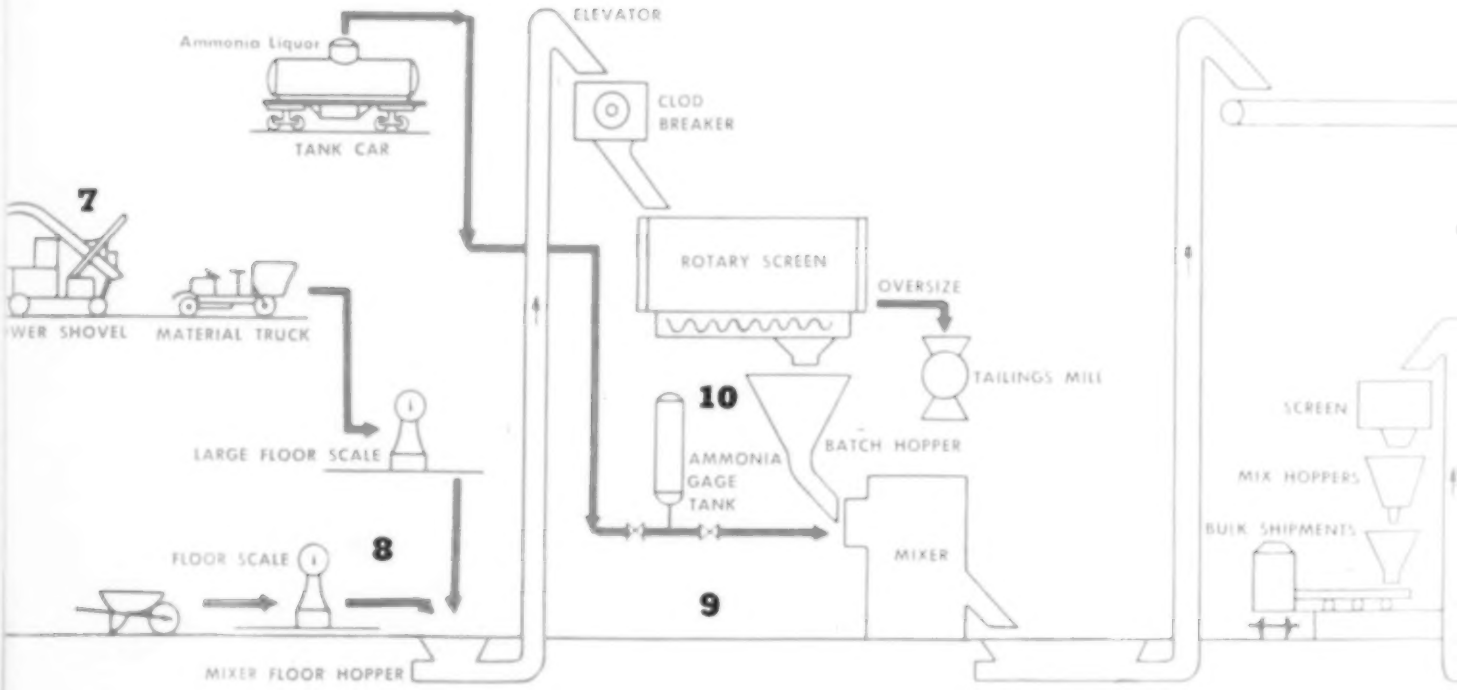
4 Fume condensation towers outside building for fluoride fume control

6 Green superphosphate sets up fairly hard in curing piles. Requires 3 to 6 weeks.

8 Superphosphate is other materials over s

te elevated to rubber conveyor belt system and ge floor where it is cured

7 After curing, the superphosphate is broken down with a light explosive, transferred by power shovel and small power truck to mixing department

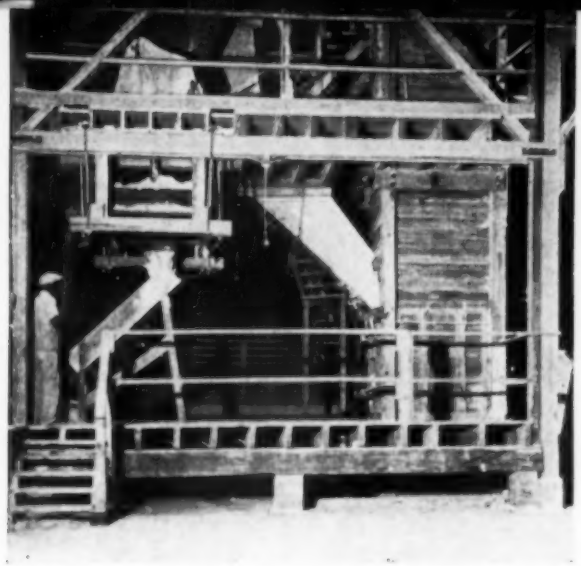


conveyed over large floor scale to mixer hopper. Small equipment brings maller floor scale to same hopper

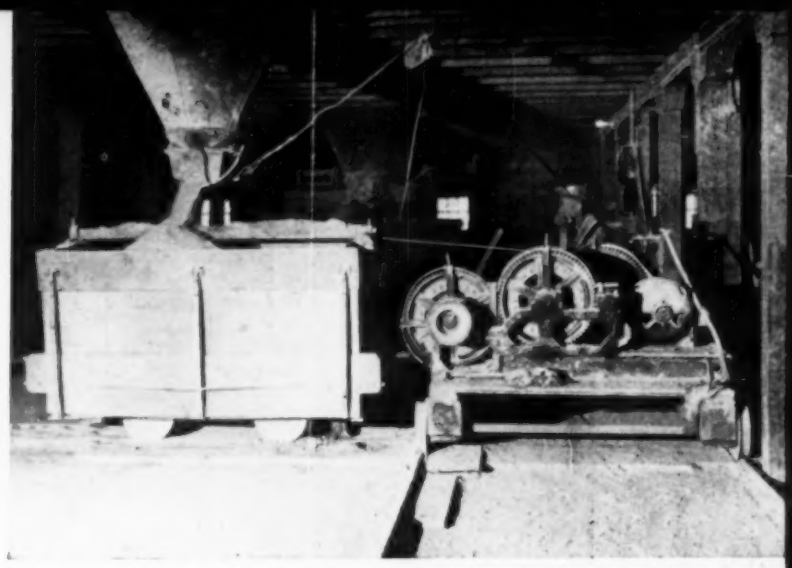
10 Mixer with batch hopper overhead and ammoniating solution gage tank at left

12 Bag fillin farmers' truc

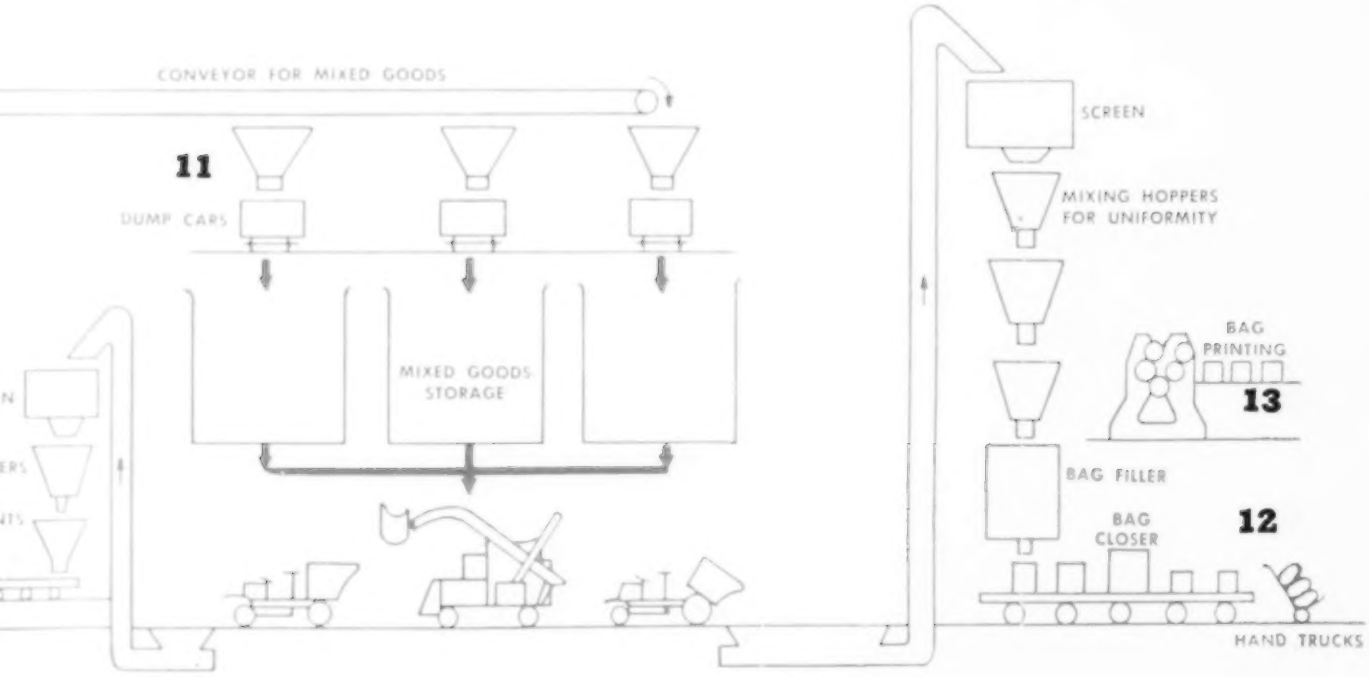
ferred



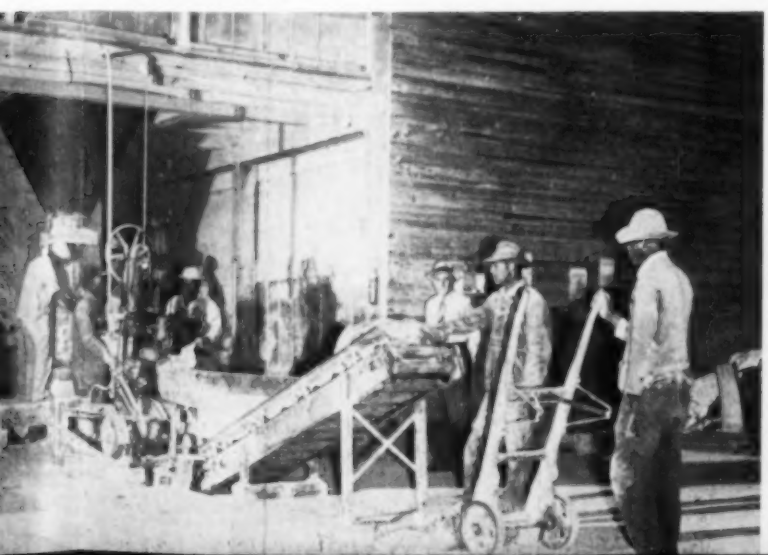
9 Ground floor view of mixer system. The mixer is a baffled shell rotating on a horizontal axis



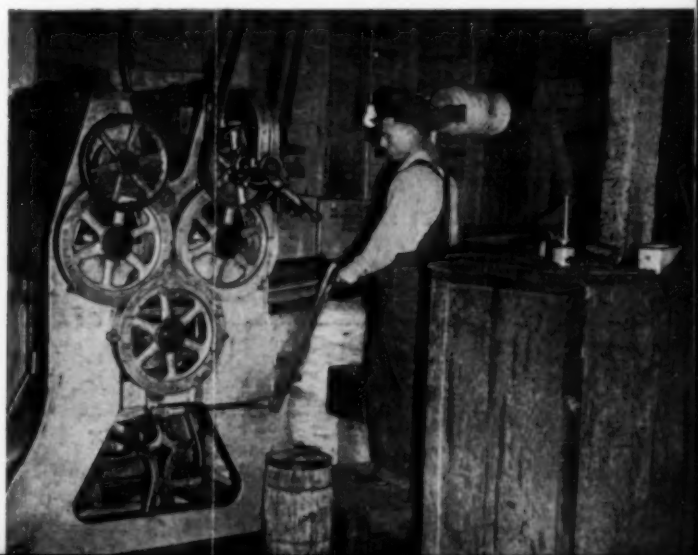
11 Finished fertilizer ready for final curing is carried by belt conveys and dump car system to curing bins

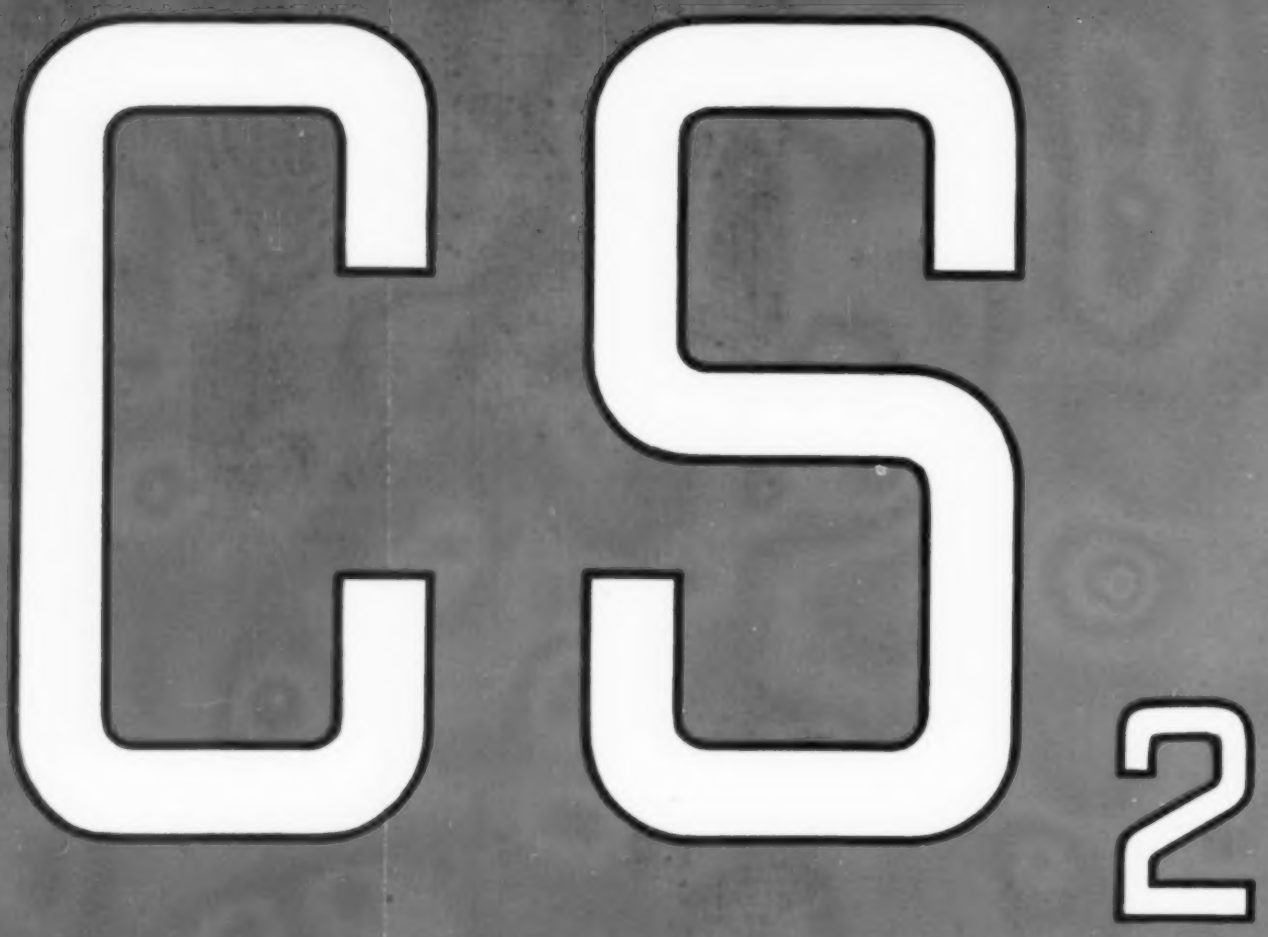


12 Bag filling and bag closing crew with trucking by hand to railway cars, farmers' trucks or warehouses



13 Bag printing press, operated by two-man crew for day to day bag supply at Hartsville, S.C., plant





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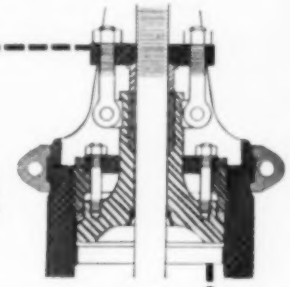
Note comparative dimensions of 1500-Pound Crane Pressure-Seal Steel Gate Valve and of conventional design. Both are 8-inch. In every size, these new valves give you important space-saving advantages. Require less head-room to operate.



HOW THE LEAK-PROOF PRESSURE-SEAL BONNET JOINT OPERATES

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The approximate table, shown in the diagram below, indicates the relative fineness range of the Raymond Vertical Mill.

Where other Raymond fine grinding mills can approach a fineness of 99% or slightly better, passing 325-mesh at the fine end, the Vertical Mill can continue on up to particle sizes as small as 99% finer than 10 to 15 microns, and even to 5 or 10 microns for some materials.

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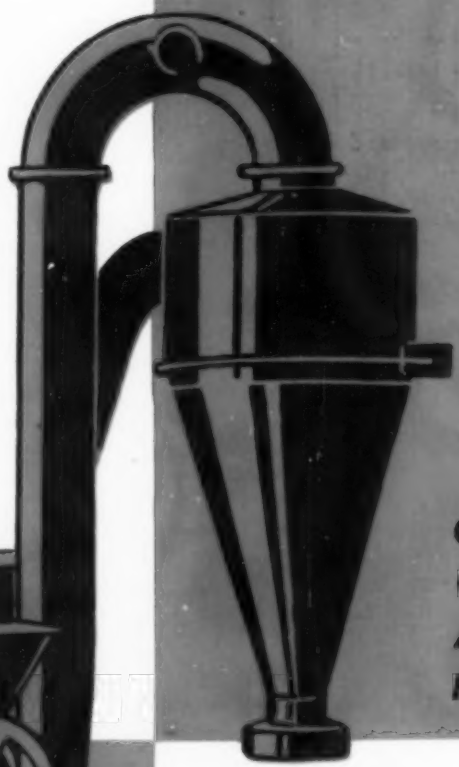

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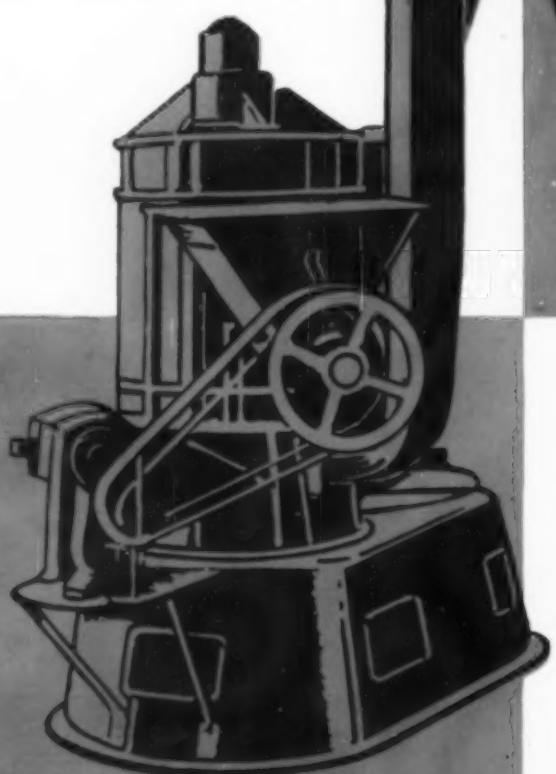

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100% Minus	Range of
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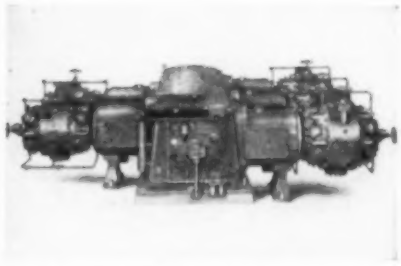
PROCESS EQUIPMENT NEWS

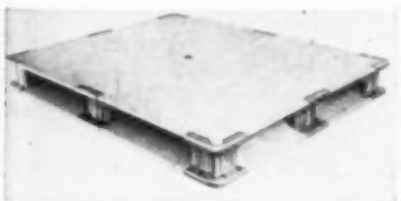
Theodore R. Olive, ASSOCIATE EDITOR



Space-saving five-cylinder compressor

1. Motor-Driven Compressor

SPACE conservation is an important characteristic of the new Type JM motor-driven compressor recently added to the line of the Cooper-Bessemer Corp., Mount Vernon, Ohio. Produced in six sizes with from one to six crank throws, and a great variety of compressor cylinders, these compressors range in horsepower from 500 to 2,750. Speed is 300 r.p.m. and the compressor stroke 14 in. Power for driving is taken from a standard synchronous electric motor, an engine or a turbine. Provision can be made for low vacuums or for high pressures, as well as for intermediate pressures. The low- and medium-pressure compressor bodies are of Meehanite metal, while high-pressure bodies are of cast or forged steel, as required. Cylinder valves are a standard ring-plate type, and are self-cleaning.



Plywood four-way pallet

2. Plywood Pallet

CONSTRUCTED with $\frac{5}{8}$-in. plywood decks, and posts of plywood blocks or metal, a durable pallet of the double-face, four-way fork entry type has been introduced by the Clark Tructractor Division of Clark Equipment Co., Battle Creek, Mich., for use with both hand-lift and motorized pallet trucks. The pallet is said to weigh only a little more than half as much as a comparable hardwood pallet. Available sizes range from 30x40 in. with a 2-in. vertical clearance, weighing 36 lb., up to 48x60 in., with $3\frac{3}{4}$ in. clearance, weighing 89 lb. Capacities are 4,000 lb. carrying, and 16,000 lb. static load.

CONTENTS

3. Composite Insulation

ALTERNATE layers of asbestos paper and aluminum foil which can be built up to any desired thickness are employed in a new insulation covering developed by the Ric-Wil Co., Union Commerce Building, Cleveland, Ohio. Intended for use both indoors and out, for steam and hot water piping, the composite character of the insulation is said to afford better protection against heat loss, at the same time insuring that the covering will hold its shape.

This same manufacturer has also introduced an asphalt-copperclad prefabricated insulation for pipe units, for both inside and outside overhead steam line use. The copper sheeting is wound spirally around the insulation material and is made to adhere to the insulation by a layer of asphalt. The insulation is applied at the factory by special machinery although it may be applied to the buyer's own pipe, if desired. Also, if desired, other metals or materials in thin sheet form can be substituted for the copper to meet special conditions.

FOR MORE INFORMATION
See Reader Service Coupon on pages 155-156

Veritron electronic pyrometer controller

4. Pyrometer Controller

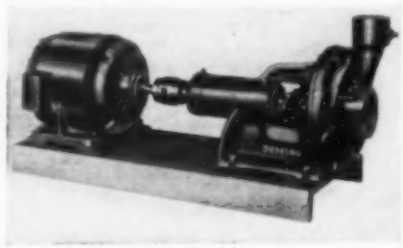
UNIQUE features including a new electronic circuit, extra compact design and simplified operation are found in the new Veritron electronic pyrometer controller recently announced by Taco West Corp., 2620 South Park Ave., Chicago, Ill. The instrument is of the two-position type and is said to be particularly suited to direct installation on industrial furnaces and plastic molding machines. In operation the control pointer is set at the desired temperature and control is immediately established within what is said to be an exceptionally narrow

temperature range. The design permits the instrument movement to operate a heavy-duty relay system without physical contact or reaction effect on the indicating pointer. The built-in relay has a 3-kw. non-inductive load capacity. The electronic circuit, which requires no tuning or other adjustment by the user, has no high frequency oscillator system, capacitance system or mechanical clamping mechanism. The electronic control mechanism is said to be absolutely stable, giving chatter-free relay operation. It is claimed to be unaffected by line voltage variations, tube aging or component changes. The measuring system is well compensated for cold junction deviation and other errors. Owing to a newly developed method for rigid fastening to secure mechanical alignment, the instrument is said to be undisturbed by stresses and strains due to vibration, shock or ambient effects.

Seven-tube Karbate exchanger

5. Karbate Exchanger

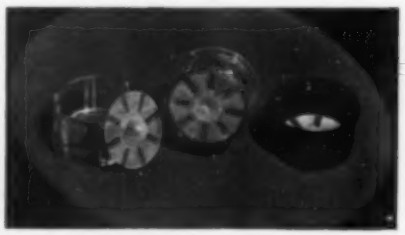
A SEVEN-TUBE Karbate impervious-graphite heat exchanger, for use under highly corrosive conditions, is now being produced by National Carbon Co., 30 East 42d St., New York 17, N. Y., in three standard sizes of 4 ft. 3 in., 7 ft. 3 in., and 10 ft. 3 in. length. All three units employ 1-in. I. D. by 1½-in. O. D. Karbate tubes in bundles incased in a standard 6-in. I. D. steel pipe shell. Except for pipe length, the exchangers are all identical, with all tube bundles and shells of the same size interchangeable. These exchangers are suitable for temperatures to 338 deg. F. and working pressures to 50 psi. on both tube and shell sides. Standard nozzle connections permit ready installation with piping connections of almost any material of construction. Water, brine or steam are suitable on the shell side. In addition to having resistance to practically all acids, alkalis and other corrosive or solvent agents, these exchangers feature high thermal conductivity, about three times as high as carbon steel. The 4½ ft. size has 8.2 sq. ft. of effective outside tube area; the 7½ ft. size, 16.4 sq. ft.; and the 10½ ft. size, 24.6 sq. ft.



Direct-connected double-bearing pump

6. Side-Suction Pump

WIDE RANGE of application to pumping requirements is the aim said to have been achieved by the Deming Co., Salem, Ohio, in the introduction of a new line of standardized side-suction centrifugal pumps. These pumps are made in three types, using, respectively, a single ball bearing with open type impeller, two ball bearings with an open impeller and two ball bearings with a semi-inclosed impeller. Each type is made for belt drive or for direct connection to the electric motor. The line includes five sizes ranging from ½ to 2 in. side suction, with capacities from 2 to 200 g.p.m. The pumps employ a bolted stuffing box gland, grease-lubricated bearings and a casing which may be turned easily to give various positions of the discharge nozzle. The first two types are rated for 50 ft. head, and the last for 70 ft. The pumps are suitable for booster service where the suction pressure does not exceed 25 lb.



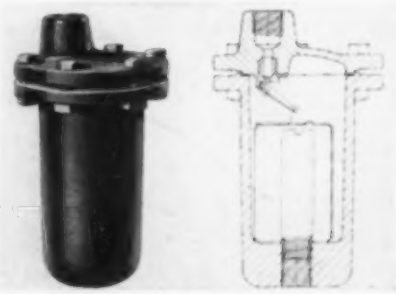
New carboy closure

7. Carboy Closure

FOR USE on carboys carrying sulphuric, hydrochloric and nitric acids, as well as hydrogen peroxide up to 35 percent, and sodium hypochlorite, the Owens-Illinois Glass Co., Toledo, Ohio, has developed a new polystyrene closure, with a new type polyethylene liner which has received tentative approval of the Manufacturing Chemists Association. The cap also meets Interstate Commerce Commission requirements. As shown in the accompanying illustration, the new liner, said to be superior to the type formerly used, consists of eight radial spokes and a hump in the center which insures that the liner will be inserted correctly in the closure. The device is designed to vent at pressures not exceeding 10 psi.

8. Circuit Breaker

UNDER the name of Quicklag, the Westinghouse Electric Corp., P. O. Box 868, Pittsburgh 30, Pa., has introduced an improved line of circuit breakers in which a new tripping action is provided, combining the inverse time limit characteristics of bimetal thermal action on overloads, with the operating speed of magnetic trip action on short circuits. These breakers are available in single or double-pole designs for 10 to 50 amp., 125 to 125/250 volts a.c. As another improvement, these breakers employ a redesigned "De-ion" arc chute that eliminates the need for a vent screen in the bottom, thereby permitting mounting flush to the pan. This eliminates the need for the ¾ in. mounting clearance formerly required. The breakers also include a sturdier operating handle which is more inclosed than the old one, internal design requiring less handle movement; and a hole in the handle permitting a more satisfactory method of attaching a handle extension for two-pole operation.



New forged steel steam trap

9. Forged-Steel Trap

FOR PRESSURES up to 250 psi., Armstrong Machine Works, 858 Maple St., Three Rivers, Mich., has introduced a new small-sized, forged-steel steam trap which, as the accompanying illustration indicates, employs this company's basic inverted bucket and free-floating valve lever design. The body and cap are steel forgings, capable of resisting pressures considerably in excess of

JOIN COMFORT WITH PROTECTION FOR YOUR *Toxic Gas* and *Vapor Hazards!*

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INDUSTRIAL Gas Masks

Where the hazards of individual gases or combinations of gas, smokes, vapors or dusts are potential in your operations, the specific protection of M.S.A. Industrial Gas Masks affords desirable respiratory safety for your workers. A complete range of long-lived, replaceable canisters is available, enabling you to match *specific protection to specific hazards.** Featuring the famous M.S.A. All-Vision Facepiece, for wide-angled vision and comfortable gas-tight seal on face, the Masks are quickly applied and do not hamper working freedom. Write for full description and list of gases for which protection is afforded, in Bulletin No. ED-11.

For respiratory protection against specific gases or groups of gases, with interchangeable canisters.

* Carbon monoxide and illuminating gas excepted. See M.S.A. All-Service Gas Mask below.

M·S·A

ALL-SERVICE Gas Mask

Providing respiratory protection for the worker against combinations of carbon monoxide and all other poisonous industrial gases, vapors and smokes with a single, replaceable canister, the famous M.S.A. All-Service Gas Mask meets *any* respiratory emergency in the plant, wherever a canister mask can be used. Officially approved by the U. S. Bureau of Mines, the All-Service Mask is available in Standard Model with regular canister, and Model S equipped with canister containing a special filter for added protection against toxic dusts, mists, fogs and smokes. Both models feature the M.S.A. All-Vision Facepiece, can be put on and adjusted rapidly, and provide excellent wearing comfort. Bulletin No. EA-8.

For respiratory protection against ALL industrial gases—singly or in combinations, including CO.

MINE SAFETY APPLIANCES COMPANY

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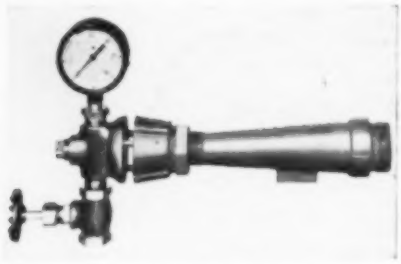
normal operating pressures. All interior operating mechanisms, including the valve seat are stainless steel. Measuring about 4¼ in. in diameter with an overall height of 7 in., the trap has an average capacity of 900 lb. of condensate per hour at continuous discharge.



High pressure air-gas mixer

10. Gas Mixer

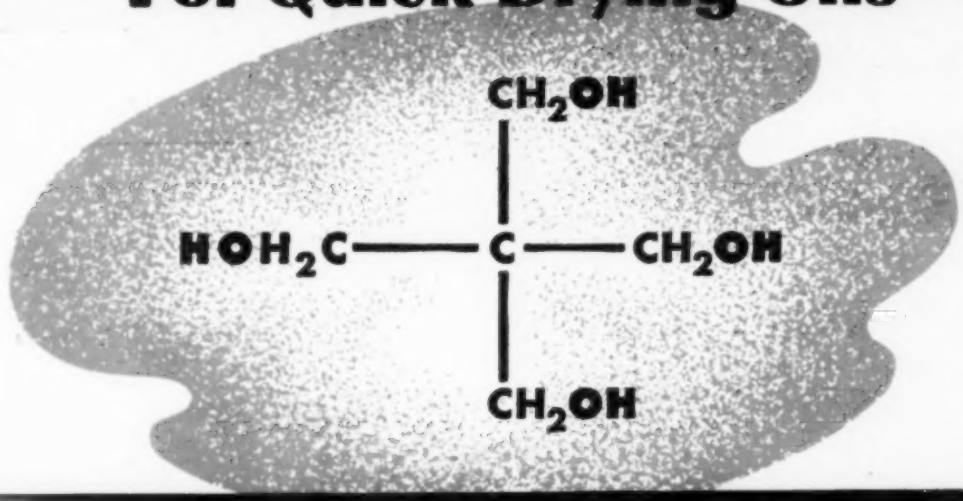
IMPROVED mechanical features are incorporated in a new venturi mixer for high pressure gases which has been announced by the Industrial Division of Byrant Heater Co., 17825 St. Clair Ave., Cleveland, Ohio. Known as the Hijector, the new unit uses gas under pressures as high as 36 lb. to entrain all the air needed for combustion and deliver the mixture to the burners at the highest possible pressure. Overall length of the unit has been substantially reduced as compared with conventional designs by rearranging the elements for ease of servicing. Air entrainment noise has been reduced while both orifice and air entrainment areas are readily accessible for inspection or cleaning. Sizes are available for pipes ¾ to 4 in., for all types of fuel gases.

Worm-geared hose clamp

11. Stainless Hose Clamp

DEVELOPED originally to meet military aircraft standards, a stainless steel hose clamp known as the Aero-Seal is now being marketed for industrial use in making tight, permanent joints on rubber hose lines for air and liquids. As the accompanying illustration shows, the clamp is equipped with a worm gear drive which is said to give

For Quick-Drying Oils



PENTEK®

Pentaerythritol, Technical Grade

Pentaerythritol drying oils are noteworthy for

● Quick drying ● Quick bodying ● High gloss ● Water resistance ● Good aging qualities ● Hardness of film ● Toughness of film.

Pentek finds valuable application in coating compositions of alkyd, urea-formaldehyde, and modified phenolic resins . . . in plasticizers, emulsifying agents, and waxes . . . and as a glycerol replacement.

AVAILABILITY: 75-lb. multi-wall paper bags.

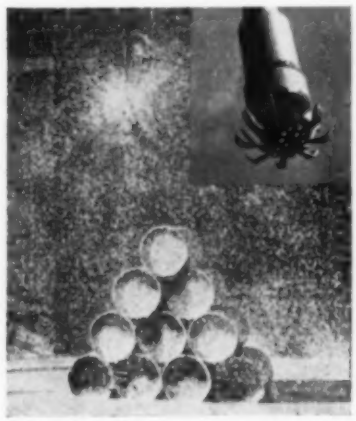
Technical literature will be sent upon request.

FINE HEYDEN CHEMICALS

HEYDEN CHEMICAL CORPORATION
393 Seventh Ave., New York 1, N. Y.
CHICAGO OFFICE, 20 North Wacker Drive
PHILADELPHIA OFFICE, 1700 Walnut Street

FOR MORE INFORMATION
See Reader Service Coupon on pages 155-156

uniform clamping pressure. Other features include extra band strength, extra long take-up, ease of installation and re-usability. The clamp is available in a wide range of sizes and is said not to distort or collapse thin wall tubing.



Foam spray deflector in action, and deflector head (see insert)

12. Overhead Foam Spray

SAID TO BE especially effective over hazards where flammable liquids are stored, particularly where a water spray would tend to spread the flame, a new overhead spray deflector system has been developed by National Foam System, Inc., 1400 Packard Building, Milwaukee 2, Pa. Employing this company's Aer-o-foam liquid, the new equipment distributes the foam which quickly blankets and smothers the fire. The foam may be supplied either from a fixed independent unit which may be completely automatic, or it may be supplied through permanent piping with hose connections at the outer end hooked up with a special foam truck. The spray deflectors are made in three standard sizes for four different water pressures. The equipment consists of a brass foam maker with a steel discharge tube and brass dispersion head. Although generally arranged to discharge vertically downward, the foam deflector may be placed at various angles. The foam liquid produces a cohesive smothering blanket with 0.6 per cent of the liquid mixed with 9.4 percent of water (fresh or salt) and 90 percent air. At 50 lb. water pressure the area protected by a single overhead spray deflector varies from 47 to 190 sq. ft., depending on the type model.

JESSOP and ALAN WOOD

complete working agreement

for expanding production of stainless-clad sheets

Jessop Steel Company and Alan Wood Steel Company announce the completion of a working agreement for large scale production of stainless-clad sheets by the patented Armstrong method.

Combined technical knowledge, experience and equipment of both companies will be utilized in expanding production.

Stainless-clad sheets will be available in greatly increased quantities for industrial equipment, commercial products, and home appliances.

New opportunities are open to manufacturers who recognize the advantages of stainless-clad sheets in modern design.

Consider the items you manufacture . . . may we assist your design engineer?

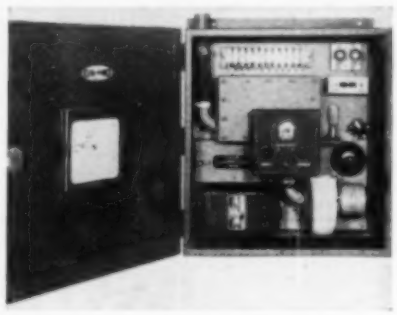
JESSOP STEEL COMPANY
Washington, Penna.

ALAN WOOD STEEL COMPANY
Conshohocken, Penna.

Pusher removing bags from pallet

13. Load Pusher

ONE OF the most recent devices to be adapted to the standard fork truck by Clark Tructractor Division of Clark Equipment Co., Battle Creek, Mich., is a new pushing attachment which enables materials to be unloaded from the pallet directly on to the factory or car floor. The pallet may either be deposited with the load, or retained on the forks, and the pusher may also be used with self-contained loads which do not require pallets. The pushing device has a maximum stroke of 52 in., and a thrust capacity of 4,000 lb. It is available on a variety of this company's fork trucks.



Quick acting smoke detector

14. Firefighting Devices

SEVERAL new developments have been announced by the C-O-Two Fire Equipment Co., Box 390, Newark 1, N. J. Included among these is a new industrial smoke detector, designed to detect fires in storage or record vaults or other spaces in industrial plants. This detector, using an inclosed light beam, is the first, according to the manufacturer, to be fully approved by the Underwriters' Laboratories. It operates on the principle of light reflected by smoke particles on to a photoelectric cell. Air samples are drawn continuously into a detecting chamber. At the first sign of smoke, a red smoke indicating lamp is lighted and an alarm sounds.

Among improvements in carbon dioxide firefighting equipment is an improved light-weight hose reel, available in capacities from 50 to 200 lb.

EVERY FABRICATED PIPING CUSTOMER of EACH MIDWEST PLANT BENEFITS FROM THE FACT THAT THERE ARE

Strategically located in various parts of the country, all of the four Midwest plants are of definite benefit to every Midwest customer.

Undoubtedly the most important advantage is the better piping that results from the continuous exchange of information and experience between the four plants. For example, if Passaic develops a new and valuable technique or method, the information is made available at once to St. Louis, Los Angeles, and South Boston. When Los Angeles finds a better way to control grain size in forged lap joints, the other plants are immediately informed. Regardless of which plant fabricates your piping, you get the benefit of the combined experience of all four plants.

Other advantages are greater flexibility in meeting delivery requirements . . . a better understanding of regional conditions . . . source of supply close to the job.

Midwest is logically your first source of piping—whether you want a simple bend, a welded header, or a complete and complex piping job for a large plant fabricated and erected with undivided responsibility.

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4 PLANTS ARE BETTER THAN 1

PIPING FABRICATORS AND CONTRACTORS

or more carbon dioxide. The reel may be fitted with ¼-in. high pressure hose of any length up to 125 ft. and may be installed either adjacent to a manifolded group of carbon dioxide cylinders, or at a remote point. The fire-fighting nozzle is equipped with a squeeze-grip valve for controlling the discharge of gas when working around a fire. The company has also announced a new type carbon dioxide hose rack which may be used either as a fixed rack, or picked up and carried to a fire. The cylinder brackets are permanently fastened to a wall or column, but provided with quick opening clamps to permit easy removal of the cylinder. Four carrying handles are provided. The cylinder contains 50 lb. of carbon dioxide and is fitted with 25 ft. of ¼-in. high pressure hose terminating in a discharge horn, equipped with a squeeze-grip valve. The entire unit weighs 240 lb. It is intended for industrial fire hazards not large enough for a permanent type system, but too large for portable hand extinguishers.

Net-weight dry material feeder

15. Dry Product Filler

THRIFTY WEIGH is the name of a new net-weight filling machine for dry products introduced by Glengarry Machine Works, Bay Shore, N. Y. This machine is a combination of a vibratory feeder and a weight beam. It has few parts and little motion and is claimed to deliver long-time trouble-free service. Stainless steel is the only material coming in contact with the product. It is claimed to deliver the

FOR MORE INFORMATION
See Reader Service Coupon on pages 155-156

FUEL ECONOMY *plus* TEMPERATURE CONTROL

This waste heat boiler, shown during installation, recovers heat from tunnel kilns—a new application. Compactness of design and details of cast-iron, extended surface element construction are shown.

WASTE HEAT BOILERS GIVE *BOTH*

The function of waste heat boilers in chemical processing operations is two-fold —to provide close control over temperature and rate of cooling of hot, corrosive gases, and to recover heat from these gases which would otherwise be wasted.

Temperature control by other methods has proved generally uneconomical, while heat recovery and re-use to generate steam or heat water means lower fuel cost.

Constructed to resist corrosion, tubes of Foster Wheeler waste heat boilers are protected by a sheath of cast iron. Extended surface elements speed cooling and reduce gas-travel time and distance through the unit.

The complete story of waste heat boiler application in many plants is in Catalog WHB 47-4. Send for a copy to determine whether such possibilities for economy exist in your own plant.

FOSTER WHEELER CORPORATION
165 BROADWAY, NEW YORK 6, NEW YORK

FOSTER WHEELER

set weight regardless of change in density of the product and regardless of the container filled. It is capable of weighing quantities up to 2½ lb. and will handle containers ranging from 1 to 10 in. high. Not only is it suitable for container filling, but it is also claimed to be useful for metering dry ingredients into mixes.

Meter for static charge detection

16. Static Meter

KNOWN AS the Statometer, a new self-contained instrument for the location of static electric charges has been announced by Davis Emergency Equipment Co., 98 Halleck St., Newark 4, N. J. Calibrated in static volts, the instrument is claimed to be sensitive enough to detect static charges on the order of fractional volts, either negative or positive. Any voltage from zero to 750 volts can be measured. The top of the instrument carries two sockets into which an air terminal can be inserted, one socket being used for detecting negative charges, the other for positive charges. If the needle tends to go down scale, it is merely necessary to change sockets. Operation of the instrument is said to be very simple. The operating switch is turned on, the range switch is then turned to the low range position and balanced to zero. As the operator comes into the vicinity of a body charged with static electricity, the needle of the meter will start to fluctuate. This indicates the area in which the charged body is situated. The range switch is then turned to the high range position and as the operator comes closer to the charged body, the meter needle moves higher on the scale. The instrument is said to measure both above and below the sparking voltage and to be fast in operation.

17. Electronic Controller

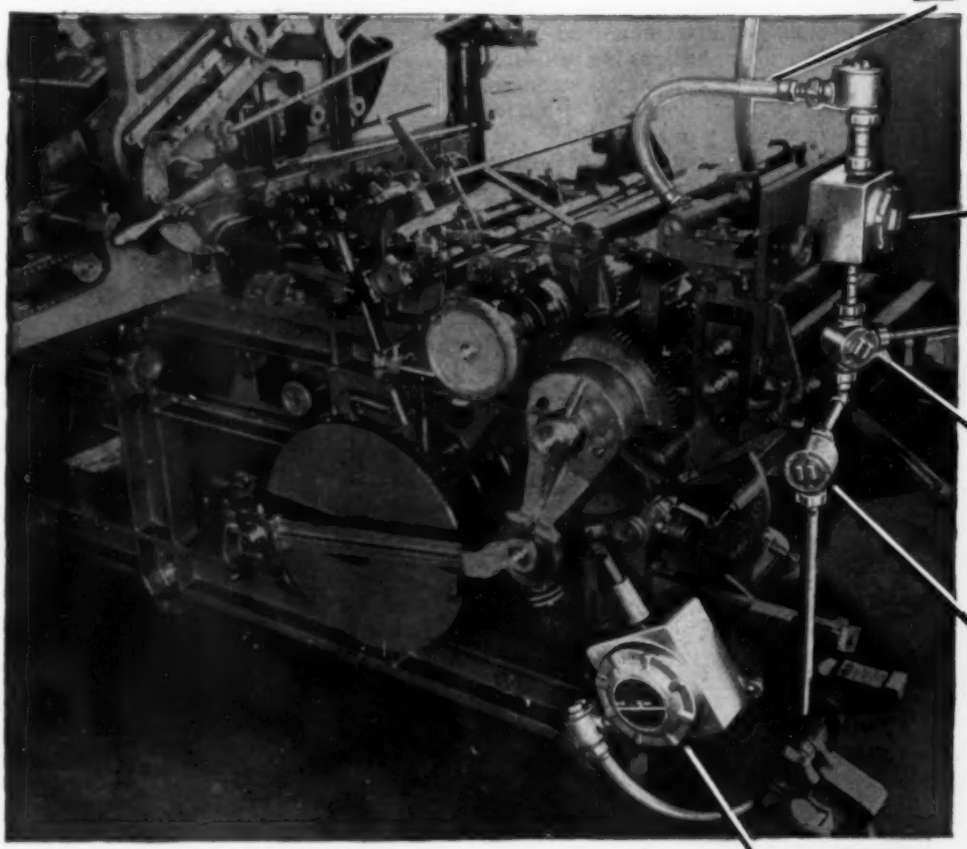
FOR USE with industrial thermometers and pressure gages, the Brown Instrument Co., Wayne and Roberts Aves., Philadelphia 44, Pa., has developed the Electr-O-Vane controller

Explosion-Proof
CONDULETS

installed on machines that may operate in **flammable atmospheres**

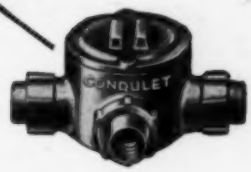
afford MAXIMUM SAFETY from explosion and fire

(CONDULETS are made only by CROUSE-HINDS)



EC Series Explosion-Proof Flexible Couplings are made in 325 types and sizes from 1/2 to 2-inch—lengths up to 36 inches.

Type GU Explosion-Proof Condulet. Can be furnished with any arrangement of hubs.



Type GUAT Explosion-Proof Condulet.

Type GUAB Explosion-Proof Condulet. There are 10 types in the GUA Series with either threaded or union hubs.

Type GUB Explosion-Proof Condulet. Can be furnished as an instrument housing or junction Condulet with any arrangement of hubs.

Locations where flammable atmospheres are likely to be present are designated as hazardous by the National Electrical Code. The Code requires that electrical installations on machines that operate in such locations, or that handle flammable liquids or gases, be explosion-proof. Crouse-Hinds Company manufactures hundreds of types and sizes of explosion-proof CONDULETS, lighting fixtures, plug receptacles and other equipment that afford maximum safety by preventing explosion and fire.

They are described in Crouse-Hinds CONDULET Catalog together with a complete line of similar equipment that is suitable for use on machines that operate under non-hazardous conditions.

Write to Crouse-Hinds Company for Condulet Catalog 2500. If you will state the nature of your requirements Crouse-Hinds engineers will be glad to make specific recommendations.

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Coupon on pages 155-156

which is said to be applicable to a great many processes requiring accurate control of temperature in the range from −100 to +1,000 deg. F. It is said that many processes formerly controllable only with electronic potentiometers can now use the new instrument successfully. This control operates on the principle that when a metal vane is interposed between two oscillator coils, as the pen deviates from the control index setting, the state of oscillation can be made to change or stop in an electronic circuit. This change or stopping of oscillation causes the electronic circuit to operate a load relay. The device thus gives a snap action type of control. It is said to be compact, self-contained, easily removed from the instrument case, and unaffected by dust or dirt.

Equipment Briefs

18. To PERMIT precise description and specification of odors, Cargille Scientific, Inc., 118 Liberty St., New York 6, N. Y., has introduced the Crocker-Henderson odor standards, which enable the odor of any material or product to be specified in terms of a four-digit number. Odor values are judged by reference to standards according to the intensities of four odor components termed fragrant, acid, burnt and caprylic (goat-like). Several thousand combinations of these four components (eight intensities of each) make it possible to assign a specific number to any odor.

19. A NEW LINE of seamless welding pipe fittings has been introduced by Ladish Co., Cudahy, Wis. Included are 90- and 45-deg. elbows, 180-deg. return bends, straight and reducing tees, concentric and eccentric reducers, caps, lap joint stub ends, saddles, shaped nipples and crosses and tees, all in carbon steel and in sizes up to 30 in. Although manufactured to various accepted standards, including those of the American Standards Association, these fittings have distinctive features, chief among which is a new tapered tee design. By scientific metal distribution, the center section and the crotch are reinforced, the metal tapering off to pipe size at the ends.

20. FOR THE handling of small units such as bottles and cartons, the Horne Machinery Co., 1188 Harrison St., San

How Multiwalls cut packaging costs 75%

and wiped out customer complaints

Customers said that burlap bags and barrels were bulky and that their workers complained about handling them. Container costs were high. The packaging operation — mostly manual — was slow, dusty, and inefficient.

This unhappy situation was causing plenty of headaches for the 67-year-old Southwark Manufacturing Company of Camden, N. J. This company packs several nonmetallic minerals, including whiting, talc, and barytes.

"We were packing our whiting in 350-lb. wooden barrels and 100-lb. burlap bags," company officials said, "but there were many disadvantages. What we needed was a mechanical packing system and a cheaper, easier-to-handle container."

About 12 years ago this company adopted an automatic packaging system—consisting of three labor-saving 105-FV St. Regis bag-filling machines and 50-lb. multiwall paper valve bags. Here are the current savings:

- **Packaging costs (labor and container) dropped 75% compared to barrels—50% compared to burlap bags.**
- **Container costs showed an 80% saving over barrels —54% over burlap bags.**
- **Labor saving totaled 50% over barrels—34% over burlap bags.**

"Customer complaints just disappeared," these officials said. "They reported that the valve bags kept their whiting clean, dry, and free flowing and that their workers liked them because the 50-lb. size was an easy load for one man. Paper bags are cleaner, too, because there's no siftage. Another big point is that they take only one-third as much storage space as barrels.

"They were so satisfactory from all angles that we switched to valve bags for our talc and barytes.

"We're sold on paper bags and so are our customers. If anyone comes to us, we'll be glad to tell him about the advantages of Multiwalls."

Mail the coupon for the detailed picture story of this operation. Learn how a St. Regis System like this can give you better packaging at less cost.

Multiwall self-closing valve bags are filled and weighed by these 105-FV packers. Only one operator is needed for each machine.

Below: A view of the storage room at Southwark Mfg. Company. Note how compactly Multiwalls stack — twenty bags high.

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Without obligation, please send me full details regarding "Case History" No. 16, outlined above.

NAME_____

COMPANY_____

ADDRESS_____

Francisco 3, Calif., has developed a table-top conveyor of sectionalized construction with several important new features, such as a renewable liner under the table top conveyor belt, complete adjustability for from 1- to 7-in. widths of package, and other developments.

21. DOUBLE-WALL vacuum flasks constructed of stainless steel, incorporating a unique radiation shield which limits the movement of heat rays through the evacuated space, are being distributed by Scientific Glass Apparatus Co., Bloomfield, N. J. These flasks, which are unbreakable and explosion-proof, are available in six sizes ranging in capacities from 400 ml. to 50 liters. The largest size (13 in. inside diameter by 24 in. inside depth) is furnished with an extra outer casing equipped with carrying handles.

22. PRE-FABRICATED entirely in aluminum, a new belt conveyor called the Mercury has been announced by the Patron Transmission Co., 129 Grand St., New York 13, N. Y. All components, such as the chain, belt, sprocket, channels, angles, frame and other parts are constructed of heat-treated aluminum alloys. The conveyor is available in widths of 6 to 60 in., heights from 15 in. up, and in sections which may be assembled in one continuous unit up to 150 ft. long in a few minutes time. Speeds up to 100 ft. per minute can be accommodated. The load capacity is 250 lb. per sq.ft. and the pulling load 6,100 lb. The belt is supported on phenolic rollers, eight to the foot. Construction is such as to permit a maximum temperature of 500 deg. F.

23. A STEAM HOSE capable of carrying 200 lb. of saturated steam pressure (388 deg. F.) for more than 300 hours under continuous flexing has been developed by the Goodyear Tire & Rubber Co., Akron, Ohio. This new hose employs spun glass yarn as a basic component to gain maximum heat resistance. The hose is said to be particularly suitable for carrying live steam for smothering oil fires. It is also suitable for hydraulic service.

24. STRENGTH of 250 to 400 percent as compared with previous rubber-fabric belts, is claimed by the U. S. Rubber Co., Rockefeller Center, New York, N. Y., for a new conveyor belt employing nylon and Ustex yarn to increase the permissible working tension of each ply two and one-half times and also to permit the use of more plies. The belt is intended particularly for heavy-duty service, as in mines and quarries. It has the advantage of low stretch lengthwise, and increased flexibility crosswise.

NEW PRODUCTS AND MATERIALS

Richard W. Porter, ASSISTANT EDITOR

CONTENTS

51. Patent Finish Plastic

Now available for the first time in continuous lengths 54 in. wide, is a plastic material with patent finish, made by the United States Rubber Co., Rockefeller Center, New York, N. Y. Known as Patent Finish Naugahyde, the material is suggested for use in upholstery, for suitcases, hatboxes and other luggage, for handbags, and for decorative panelling. Its highly polished finish repels dirt. It is flexible and forms easily around curves, corners and edges, and has good resistance to cracking. It is claimed to have high resistance to edge-wear, abrasion, scuffing, fluxing and wrinkling, and has resistance to perspiration, salt water, alcohol and other materials. Patent Finish Naugahyde is produced in black, white, vermillion, bright green, and other colors. Can be printed with designs in contrasting colors and can be made flameproof.

52. Pyruvic Aldehyde

ALTHOUGH large-scale production is anticipated in the near future, only limited quantities of pyruvic aldehyde are now available from Carbide & Carbon Chemicals Corp., 30 E. 42nd St., New York, N. Y. Known also as methylglyoxal, this material is available as an approximately 30 percent aqueous solution, a stable yellow liquid. This compound contains two highly reactive carbonyl groups and undergoes most reactions typical of aldehydes. A number of uses have been suggested, such as for the synthesis of pharmaceuticals, dyestuffs, resin polymers, and other industrial chemicals. Pyruvic aldehyde reacts with alcohol to form dialkyl and tetraalkyl acetals and with glycols to form high-boiling polymeric acetals. With polyhydroxyl compounds, it forms cross linked, water in soluble resins. It is a convenient source of peruvic acid, which is a pharmaceutical intermediate.

53. Bark Products

MANUFACTURED by the Weyerhaeuser Timber Co. under the trade name of Silvacon are five new products from the bark previously wasted in the Douglas fir timber operations in the Pacific Northwest. The bark is processed by various grinding and screening steps to produce a number of useful products.

Silvacon 383 is made up of flaky cork particles ranging in size up to ¼ in. In most physical properties it is similar to commercial cork, decomposing slowly, repelling water. It contains many highly reactive components, is phenolic-like in character and has been successfully used as a soil conditioner, in the smoke curing of meats and as a reactive ingredient in phenolic resin manufacture. Suggestions have been made for its use as an absorbent filler in explosives, in plastic accoustical products, flooring material, buffing compounds, rubber products, asphalt compounds, anti-sweat paints, gaskets and cements, in the heat treating of metals and as an ingredient in certain insecticide baits.

Silvacon 490 is a powder, an amorphous parenchymous tissue, reddish brown in color and thermoplastic by nature. Free flowing and non-budging, high in alkali solubles, it is reactive chemically. Its average particle size is 5.5 microns and its apparent specific

FOR MORE INFORMATION
See Reader Service
Coupon on pages 155-156

Utilization of bark to produce . . .

Silvacon 383, cork-like particles . . .

and Silvacon 490, an amorphous dust

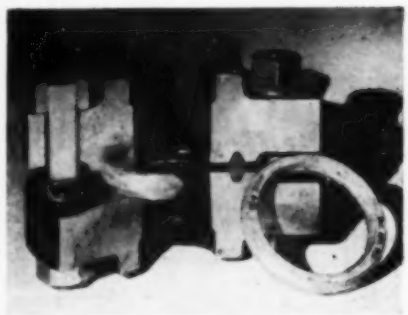
gravity is 0.28 and the pH of its water extract is 3.6. Analysis of particle size shows as follows: 200 mesh, 1 percent; 325 mesh, 9 percent; and through 325 mesh, 90 percent. This product is 52.9 percent carbon, 6.1 percent hydrogen, 40.8 percent oxygen, 0.2 percent nitrogen and 2 percent ash. For insecticide dust it is used as a conditioning agent, adjusts specific gravity and prevents caking during storage. It is also used as an ingredient in match igniting compounds. It has been suggested as a paint ingredient.

Silvacon 508 is a hard, spindle shaped fiber, $\frac{1}{16}$ to $\frac{1}{8}$ in. long, made from the hard tissue of the bark. Its average particle size is 20 microns; apparent specific gravity, 37; pH of water extract, 4. A particle size analysis shows 65 mesh, 2 percent; 100 mesh, 53 percent; 200 mesh, 44 percent; through 200 mesh, 1 percent. Chemically, it is composed of 48.8 percent carbon, 5.9 percent hydrogen, 45.1 percent oxygen and 0.1 percent nitrogen. It is used in thermoplastics, thermosetting, cold molding, and as a reinforcing filler in the manufacture of hard, high density products because it is strong and minimizes shrinkage. It may be an ingredient of magnesite flooring and an absorbent filler for explosives. Experimentally it has been used in tile flooring, buffing and abrasive compounds, casting resin reinforcing agent, hard rubber and asphalt and as a fiber paint ingredient.

Silvacon 412 is 25 percent cork and 75 percent lignified fibers. Its apparent specific gravity is 0.28, and its pH water extract is 3.9 The particle size analysis shows 65 mesh, 55 percent; 100 mesh, 34 percent; 200 mesh, 10 percent; and through 200 mesh, 1 percent. Carbon comprises 51.3 percent of the compound, hydrogen, 6.2 percent, oxygen, 42.3 percent and nitrogen, 0.2 percent. This product is used as a reactive ingredient in thermosetting molding compounds, as a binder in cold-molded plastics and as an absorbent filler in explosives. It has possibilities as a reinforcing agent in thermoplastic molding and casting resin, an ingredient in foundry core binders, for use in tile flooring and buffing, cleaning, and in rubber and asphalt compounds.

Silvacon 472 is 20 percent cork, 40 percent lignified fibers, and 40 percent parenchymous powder. Its average particle size is 10 microns, apparent specific gravity is 0.32, and the pH of its water extract is 3.9. Particle size analysis shows 100 mesh, 6 percent; 200 mesh, 45 percent; 325 mesh, 24 percent; through 325 mesh, 25 percent. It is 52.9 percent carbon, 6.1 percent hydrogen, 40.8 percent oxygen,

0.2 percent nitrogen and 1.4 percent ash. It has proven its usefulness as an extender in phenolic resin and protein adhesives, as an ingredient in match igniting compounds, and a reactive ingredient in thermosetting molding. Experimentally, it has been used for foundry parting material, foundry core binder, cold-molded plastics, absorbent filler in explosives, tile flooring, rubber adhesives, and ingredient in crop dusting compounds, welding rod casting material and linoleum cements.



Cutaway section of flanged couplings showing how the Fiberglas-plastic ring seal gasket is installed

54. Fiberglas-Plastic Gasket

ANOTHER use for Fiberglas-plastics has been developed by Plastic Engineering and Sales Corp., Fort Worth, Tex. Plies of Fiberglas cloth impregnated with phenolic resin and precision-molded under high pressure and temperature form high strength, high dielectric laminate gaskets. High dielectric strength of this new type gasket makes possible, by using it in ring seal joints, to provide insulation against the stray and long-line electrical currents that flow from connecting pipeline system into uninsulated oil and gas well structures. This cuts off currents which frequently destroy the outsides of well casings at the rate of 20 lb. of metal per ampere year. The gasket is unaffected by any of the gases and fluids encountered in the production and transmission of oil and natural gas.

55. Photosensitive Glass

A NEW photosensitive glass has recently been announced by the Corning Glass Works, Corning, N. Y. This glass, through prescribed use of ultraviolet light and heat, can receive permanent colored photographic prints with three dimensional effects. The photographic reproductions on the glass will not fade. To reproduce a picture, a negative is placed on the

glass and momentarily exposed to ultra-violet light from any one of several sources. Following removal of the negative, the photograph is developed by raising the temperature of the glass to 1,000 deg. F. The success of this process lies in the mixing of invisible sub microscopic metallic particles in the glass. Ultra violet light precipitates these particles, making them come out of solution and assume color. The three-dimensional effect achieved is due to the fact that shadowed areas penetrate farther into the glass than highlight areas. Sensitive only to ultra-violet light, the glass does not have to be handled with the same care required by photographic paper. In printing, black is used to mask off sections of the glass not covered by the negative and the process can be carried out in room light. Some of the specific uses for photosensitive glass include portrait photographs, scenic photographs, decorated glassware, church windows, photo murals, etc.

56. Masking Liquid

DEVELOPED to take the place of masking paper and masking tape, a new plastic masking liquid has been made available by the Servwell Products Co., 6523 Euclid Ave., Cleveland 3, Ohio. Known as Plask, the material has been tested for commercial use and has been found to meet all the requirements for practical, commercial applications with savings in time, labor and expense. This liquid is applied with a brush and dries tackfree in less than five seconds. It is claimed to provide complete paint-spray protection, is waterproof and airproof, and peels off easily when the masking job is completed. It may also be applied by dip, spray or roller coat after it is thinned with alcohol to the required consistency. It has a coverage of approximately 200 sq.ft. per gal. Plask is recommended for glass and all types of unfinished, plated or finished non-porous metal surfaces, including baked synthetic enamel. However, it is not recommended for use on rubber, wood or natural lacquer, or on any paint which ordinary thinner would affect. This masking liquid is available in quart containers at $1.35 each, and in gallon containers at $4.50 each. It is also available in 5-gal., 30-gal., and 55 gal. containers.

57. Ethylhexanediol

Now being produced in commercial quantities for general chemical applications by the Carbide & Carbon Chemicals Corp., 30 E. 42nd St., New York 17, N. Y., is 2-ethylhexanediol-1,3, a newly available high boiling, non-volatile glycol. This is the first

FOR MORE INFORMATION
See Reader Service
Coupon on pages 155-156

glycol of limited water solubility to be produced on an industrial scale. It was first manufactured during the war for use as an insect repellent where it has proven to be a highly effective, long lasting, pleasant to apply preparation. It is non-toxic and non-irritating to the skin, as proved by its wide use during the war. The glycol has a viscosity of between those of ethylene glycol and glycerol, but it differs from these materials in its very limited solubility in water. Containing eight carbon atoms, ethylhexanediol is compatible with hydrocarbon-like substances while still retaining the solvent properties of dihydric alcohols. As produced commercially, it has a faint odor similar to that of witch hazel. With its combination of a mild perfume odor, low volatility, compatibility with ingredients of cosmetic lotions and paints, and freedom from skin irritation, it is finding use as an ingredient for cosmetic preparations. Ethylhexanediol may also be used in the preparation of emulsifying agents and perfume fixatives.

58. Molding Polystyrene

IMPROVED molding properties are possessed by a new polystyrene molding material recently announced by the Monsanto Chemical Co., Plastics Division, Springfield, Mass. Designated as Lustron PI, this material is available in commercial quantities. Molding cycle reductions of 10 to 20 percent are claimed when this new material is used. In molding, pressures ranging up to 20 percent less than those used for standard polystyrenes can be utilized. Molding temperatures, too, can be cut as much as 30 percent with the new material. It is claimed to have a marked improvement in weld lines, in gloss, and in mold release when compared with standard polystyrenes. Burning of the material during the molding operation is eliminated.

59. Cleaning Chemical

USING a phosphoric acid base with the addition of a wetting agent and an inhibitor to prevent corrosion, a new cleaning compound is now being offered for use in cleaning dairy utensils and dairy plant equipment by the Pennsylvania Salt Mfg. Co. Known as Pennclean, this material is said to

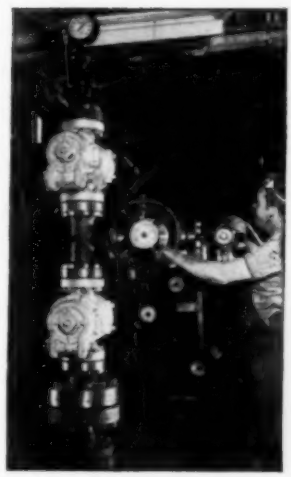
CIRCLE L 12

the alloy that meets emergencies

TWO of the best-producing oil wells in Terrebonne Parish, Louisiana were shut down—out of production. Gas distillate corrosion had rendered the valves of the Christmas trees unserviceable. The McEvoy Company of Houston, Texas are specialists in corrosion resistant Well Head equipment. They know from experience that Lebanon's Circle L 12, is a chromium alloy especially developed for this service and they telephoned us.

Quick work with patterns, molding, pouring, heat treating and finishing made it possible for us to load two of these alloy castings on a plane five days later. (*left*)

Machined by McEvoy, and tested in the assembly (*right*), the finished, corrosion resistant equipment was delivered and the wells were back in operation 8 days after that first emergency phone call.



. . . or prevents them

TODAY emergencies due to corrosion failures are unnecessary. Metallurgical progress and modern foundry practices make available a variety of alloys designed for the exact corrosive conditions which are encountered in any particular industry. Our representatives are trained to study the technical details of corrosive conditions in your production equipment. A discussion of these matters is the first step toward preventing shut-down emergencies.

Write for Data Sheet describing in detail the corrosion resistant alloy, Circle L 12.

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Lebanon CIRCLE L **ALLOY AND STEEL Castings**

remove quickly and easily the milkstone and dried-on milk which may be deposited on equipment. It has been effectively used for the removal of milkstone from dairy utensils, for daily cleaning of high-temperature dairy processing equipment, and for creamery, cheese and ice cream factory equipment where processing temperatures cause milk solids to form rapidly. It may be applied with a brush or cloth. The milk solids are readily softened and are then easily washed off.

60. Plastic Floor Tile

RECENTLY developed by the U. S. Stoneware Co., Akron, Ohio, is a laminated and decorated plastic floor tile having good sound absorption qualities and good wearing qualities. To be marketed under the brand name of Plastile, this material is a vinyl compound. Plastile is composed of a $\frac{1}{8}$-in. layer of vinyl compound bonded to a similar layer of resilient base of synthetic impregnated cork. The two plys are bonded together by the natural adhesive in the synthetic resin. Plastile is not affected by acids, alkalies, oil, grease, abrasion in any type of cleaning fluid. It needs no waxing and maintains a shiny surface. It is unaffected by moisture and is resistant to cracking or hardening.

61. Dehumidifying Agent

DISCOVERED and manufactured during the war, a new dehumidifying agent is now available for consumer use according to its manufacturer, the D. N. Coughlan Co., 29 Spring St., West Orange, N. J. Known as De-Moist, this material is designed for use in basins, closets, laundry rooms, photographer dark rooms, lockers, library and bank vaults, and in any place where air dampness and humidity should be removed or reduced. It effectively aids in the prevention of mold and mildew by removing the moisture. It was used during the war as a dehydrating agent for the prevention of damage by rust in the shipment of guns, tanks, and other valuable equipment to overseas area. De-Moist absorbs moisture up to 100 percent of its weight in a manner similar to that of a sponge. When it has absorbed its full capacity, it can be regenerated as often as desired simply by baking for an hour or two in an oven. De-Moist is available in a 12-oz. package adequate for the requirements of an average room. This package consists of a cloth sack containing the product and an outside vapor-proof container with an aluminum foil lining. The outer container is removed from the cloth sack which is hung where needed.

CHEMICAL ENGINEERING NEWS

Richard F. Warren, ASSISTANT EDITOR

New Coal Conversion Unit and Tar Refinery Being Built

AN IMPORTANT step toward more complete utilization of bituminous coal is seen in the announcement by the Disco Co., subsidiary of Pittsburgh Consolidation Coal Co., of its plans to begin construction in June of a $3 million coal conversion plant and tar refinery near McDonald, Pa. The new plant will be equipped with seven unit carbonizers with a total daily production capacity, under present operating practice, of 750 tons of Disco and will process about 1,000 tons of high volatile coal as the raw material. The present plant, containing three production units of smaller capacity, will continue producing its monthly average of 6,000 tons of this low temperature coke until the new plant is ready to begin operations, at which time the older facilities will be dismantled.

Among by-products to be produced will be an important yield of approximately 15 gallons of tar from each ton of coal charged. A high tar-acid content gives special value to the yield of tar, which will be fractionated in a tar plant. There will also be the production of some gas but this gas will be used as fuel to heat the carbonizing retorts. So far as is known at present, the company has not yet planned to recover the light oils or to treat the liquors for organic chemicals. Research is now under way for eventual recovery of such valuable materials.

Market Research Group Elects Carlisle

THE Chemical Market Research Association elected Paul J. Carlisle, manager of the market research department of du Pont's electro-chemical division, president at the annual business meeting.

George Gallup of Canadian Industries, Ltd., Montreal, was named vice president; E. I. Oppel, New Jersey Zinc Co., corresponding secretary; Dr. George Rugar, Diamond Alkali Co., recording secretary; S. P. Gibson, Jr., Commercial Solvents Co., treasurer, and the following counsellors-at-large: J. L. Finnan, Jr., assistant director of purchasing, Hercules Powder Co., L. H. Flett, National Aniline Division Allied Chemical & Dye Corp., J. G. Park, vice president of Enjay, Inc., R. B. Wittenberg, manager, potash chemical department, International Minerals and Chemical Corp.

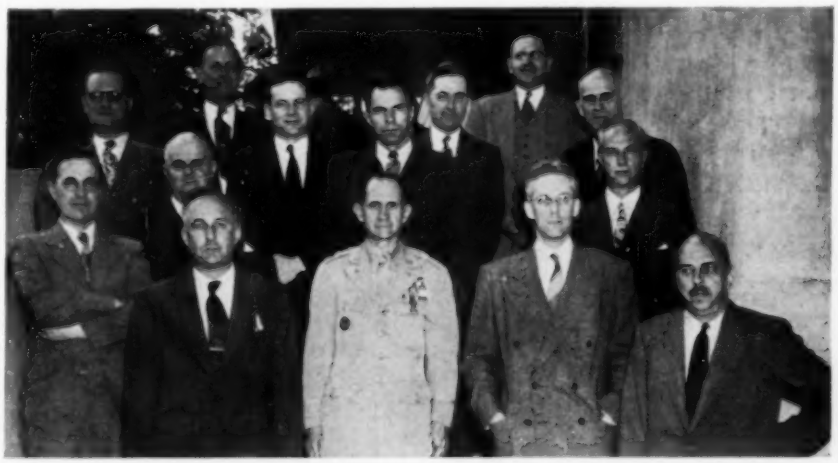
Armour to Build Chemical Plant in Chicago

CONSTRUCTION of a new plant at an estimated cost of several million dollars for expansion of a new phase of the company's business is announced by George A. Eastwood, chairman of the board, Armour & Co., Chicago. The new plant will include facilities for production of new chemicals derived from fatty oils and fats developed by the Armour Research Laboratory. Building operations will begin shortly and it is expected that the plant will be in partial operation some time during the early part of 1948 and entirely completed within 18 months.

About ten years ago Armour launched a program of research and development aimed at producing new products from fats, oils and fatty acids. Prominent among the first developments was the utilization of fatty acids to produce raw materials for alkyd resins and drying oils for paints, varnishes and enamels. Subsequently, the pure fatty acids were used as starting raw materials to produce high molecular weight aliphatic nitriles, amines and amides. Other fat derivative products contemplated include quaternary ammonium salts, ketones, synthetic waxes and a score of others which are awaiting commercial development and production.

Construction Starts on Sun Hydrocarbon Plant

CONSTRUCTION has begun on the $3 million hydrocarbon extraction plant of the Sun Oil Co. near Delhi, La. The combination absorption-compression plant will charge a maximum of 17 million cu.ft. of natural gas per day and is designed to produce a daily total of 82,000 gals. of natural gasoline, commercial propane and commercial butane. Approximately 60 percent of



The ACS committee members, who act as consultants to members of the Chemical Corps, shown above at the June 2nd meeting of the committee at the Army Chemical Center, Maryland, are advisors on chemistry and chemical engineering problems. Front row left to right: Dr. Arthur Cope, Cambridge, Mass.; Dr. W. A. Noyes, Jr. committee chairman and president of ACS; Major General Alden H. Waitt, chief of the Chemical Corps, Washington, D. C. Dr. Stanford Moore, New York; Dr. Lewis F. Fieser, Cambridge, Mass.

Background left to right: Dr. H. F. Johnstone, Urbana, Ill.; S. D. Kirkpatrick, New York; Dr. Carl B. Marquand, Army Chemical Center, Md.; Dr. Charles C. Price, South Bend, Ind.; Dr. Glenn T. Seaborg, Berkeley, Calif.; Harold Weaver, Army Chemical Center, Md.; E. R. Baker, Cincinnati, Ohio; Dr. P. K. Frolic, Rahway, N. J.; Dr. W. R. Kirner, Washington, D. C.

the propane present in the natural gas, and substantially all the butanes and heavier hydrocarbons, will be extracted. The project is expected to be completed near the end of 1947. Design, engineering and construction is in the hands of Petroleum Engineering, Inc., Houston, Texas.

Swift Erects Fats and Oil Processing Unit

AN IMPORTANT step in improving the supply of fats and oils is being taken by Swift & Co., with the announcement of plans to erect a fats and oils processing unit in Hammond, Ind. The new facilities of the technical products plant will pioneer the development of valuable fractions from animal, vegetable and marine oils expected to result in processing economies.

The plant will include the first announced application of the Solexol Process, recently introduced by M. W. Kellogg Co. This process physically

CONVENTION CALENDAR

American Association for Advancement of Science, chemical research conferences, Colby Junior College, New London, N. H., June 16-Aug. 22.

Chemical Society, centenary of foundation, London, July 15-17.

Instrument Society of America, second annual instrument conference and exhibit, Stevens Hotel, Chicago, Ill., September 8-12.

Porcelain Enamel Institute, annual forum, Ohio State University, Columbus, September 10-12.

American Chemical Society, 112th national meeting, New York, September 15-19.

National Petroleum Association, 45th annual meeting, Hotel Traymore, Atlantic City, N. J., September 17-19.

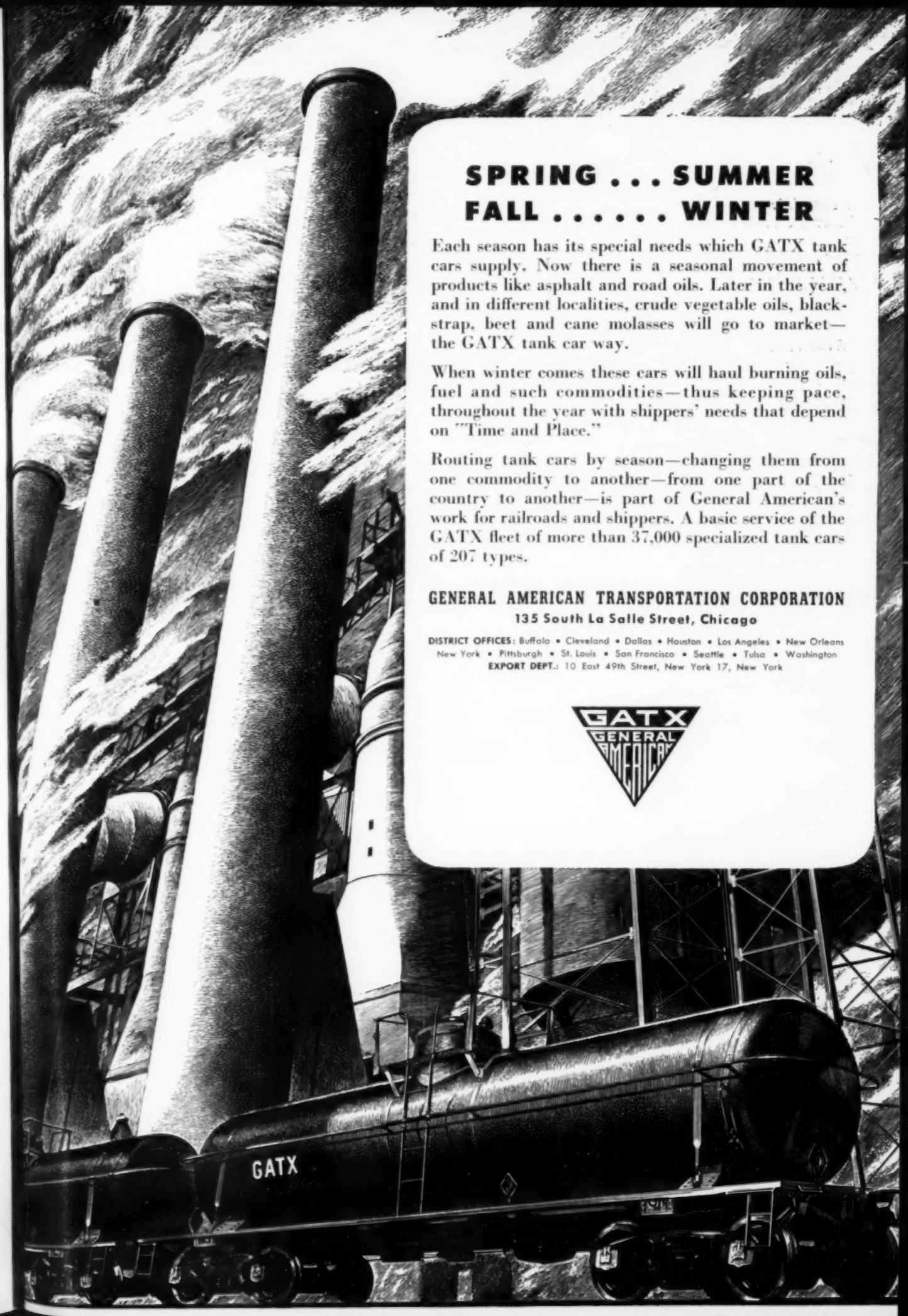
American Institute of Chemical Engineers, regional meeting, Hotel Statler, Buffalo, N. Y., September 29-October 1.

Electrochemical Society, fall congress, Copley-Plaza Hotel, Boston, Mass., October 15-18.

Pacific chemical exposition, Civic Auditorium, San Francisco, Calif., October 21-25.

Exposition of Chemical Industries, 21st exposition, Grand Central Palace, New York, N. Y., December 1-6.

American Society of Heating & Ventilating Engineers, eighth international heating and ventilating exposition, Grand Central Palace, New York, February 2-6, 1948.



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FALL . . . . . WINTER

Each season has its special needs which GATX tank cars supply. Now there is a seasonal movement of products like asphalt and road oils. Later in the year, and in different localities, crude vegetable oils, blackstrap, beet and cane molasses will go to market—the GATX tank car way.

When winter comes these cars will haul burning oils, fuel and such commodities—thus keeping pace, throughout the year with shippers' needs that depend on "Time and Place."

Routing tank cars by season—changing them from one commodity to another—from one part of the country to another—is part of General American's work for railroads and shippers. A basic service of the GATX fleet of more than 37,000 specialized tank cars of 207 types.

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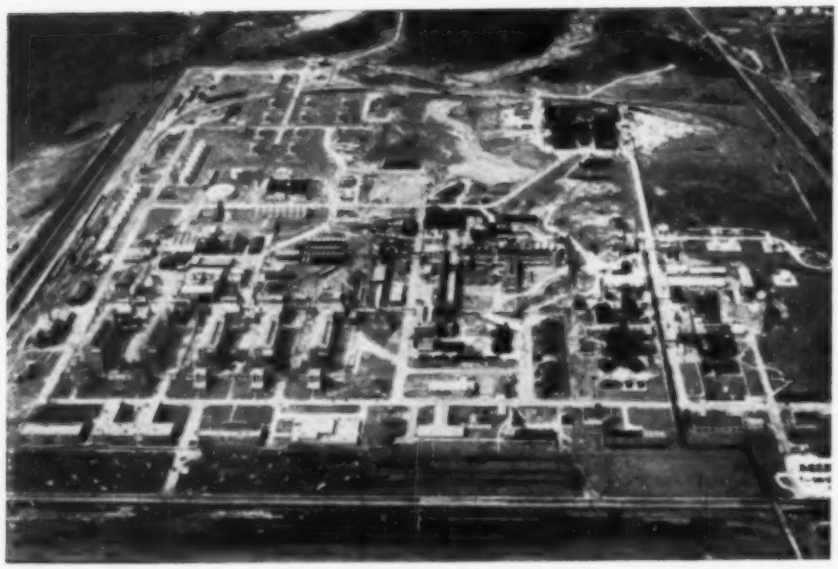

Ethyl Corp. plant at Baton Rouge, La. Additions will be made to the tetraethyl lead area (left), to the sodium operations (center), and to the ethyl chloride installations (right) as part of a $20 million expansion program

separates glyceride oils into fractions differing in molecular weight and structure. Contracts for the design and construction of three different units have been awarded to the Kellogg Co.

One unit, designed principally to decolorize glycerides and fatty acids, will accomplish this with a high yield of valuable products for soap manufacture. It also is designed to operate on crude linseed oil and, by concentrating the color bodies and other undesirable anti-oxidants into a small fraction of low processing cost, to produce exceptional yield of high-quality oil. Soybean and other oils also are planned as alternate products.

Another unit, a destearanizing plant, will separate glycerides and fatty acids into high quality stearine and a clear oil of low pour point. Stearine will be precipitated by chilling, using the solvent itself as the refrigerant, and then separated by filtering in special continuous rotary filters.

The third unit is a plant equivalent in detail and scope to the first two units but scaled down to 1-2 hundredth of their size. It will be used to exploit and develop operating conditions for the larger units and also may be used to produce high potency vitamin concentrates.

American Oil Chemists Elect Officers

Dr. Reid T. Milner, Peoria, Ill., was elected new president of the American Oil Chemists' Society at the closing session of the 38th annual convention held in New Orleans. The convention chose New Orleans for the 1948 meeting. Other officers elected included C. P. Long, Cincinnati, first vice-president; E. M. James, Cambridge, Mass., second vice-president; V. C. Mehlenbacker, Chicago, third vice-president; L. B. Parsons, Cambridge, fourth vice-president; H. L. Roschen, Chicago, secretary, and J. J. Vollertsen, Chicago, treasurer. Felix Paquin, Galveston, Tex., first president of the association, and Mr. Vollertsen were given honorary life memberships in the society.

Colorado Shale-Oil Unit Starts Operating

The U. S. Bureau of Mines $2 million shale-oil demonstration project at Rifle, Colo., has passed the preliminary design stage and will now gather actual cost data on the mining, retorting and refining of shale oil into fuels, waxes and possibly lubricants. Two highly instrumentized NTU batch-type retorts have been constructed by Southwestern Engineering Co. and are now in operation. Each capable of holding 40 tons of raw shale, these have an inside diameter of nine feet, are 20 ft. long, internally heated and together can produce up to 200 bbl. of crude shale oil daily.

Feed for the retorts will be trucked from a small shale mine some five miles away. After being crushed, the shale is stored in 100-ton bins. An 80-ton-per-hr. capacity conveyer carries the ore to the top of the retorts. Trials limited to 80 tons daily are scheduled for preliminary operations.

Although tests have shown that shales run up to 80 gal. per ton in oil content, the usual range in this area is about 15-30 gal. Located in Naval Oil-Shale Reserve No. 1, the principal reserve is 500 ft. thick and covers 50

IN THE LABORATORY TODAY— IN TANK CARS TOMORROW

Before an Oronite product is offered to industry, you can be sure it has proven its value and performance in Oronite laboratories. Here, each new industrial chemical is subjected to rigorous tests; examined and re-examined in the light of analysis and research.

Today, Oronite prepares for future quantity deliveries of an increasingly useful and broadened line of industrial chemicals. We're working now to take the uncertainties out of your production in the future.

ORONITE CHEMICAL COMPANY

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Standard Oil Building, Los Angeles 15, California

Architectural perspective shows Corn Products Refining Co. processing plant at Corpus Christi, Tex., being built to produce dextrose, starches, and high protein livestock feeds, from milo maize. It will have a capacity of 20,000 bushels of maize per day and will be completed in time to process the 1948 crop. H. K. Ferguson Co. is in charge of the design and construction of the plant

sq.mi. Total United States reserves are estimated at 144 billion bbl. of oil, of which 64 percent may be recoverable. Some 76 billion bbl. are sealed in the Green River formation of western Colorado.

In the refining stage at Rifle, contract has been awarded to Refinery Engineering Co. for the design, fabrication and construction of a 200-bbl. daily crude capacity refinery consisting essentially of an acid treating and a Dubbs cracking plant. This refinery is scheduled for completion by late 1947.

Surplus Tacoma Coke Plant And Mine Sold

SALE of a $945,000 coke and by-products plant at Tacoma, Wash., and a coal mine at Nearby Wilkeson to Richard E. Randall, president of Consolidated Coal Mines, Inc., for $600,000 has been announced by WAA. Operated during the war Wilkeson Products Co., both have lain idle for

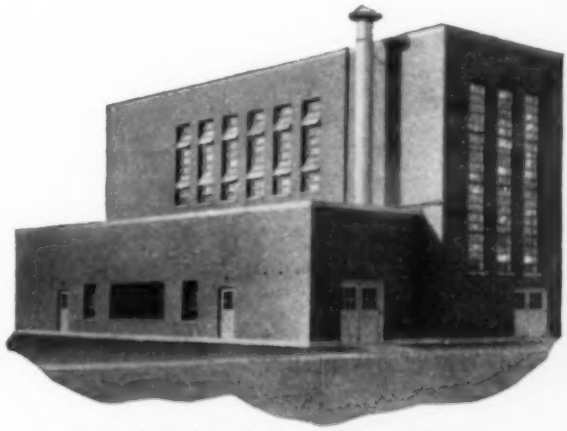
WITH THIS NEW RESEARCH PLANT

SWENSON *can help you obtain the advantages of* Spray Drying

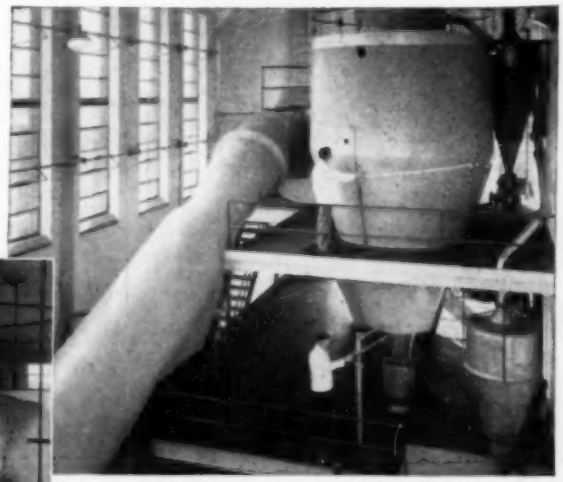
NOW it is possible to conduct spray dryer tests of any pumpable, dryable substance on a production scale under normal operating conditions. New research facilities recently completed at Harvey, Ill., enable Swenson engineers to evaluate the use of spray drying for various chemical processes, and bring its many advantages to new applications in the industry.

Spray drying may be used for both organic and inorganic materials, including those particularly susceptible to heat. It produces a powder of uniform particle size and high solubility. The Swenson process operates as a closed system, assuring freedom from contamination and recovery of all the solids contained in the mother liquor.

Can spray drying improve your product or any process in its manufacture? Swenson engineers will gladly consult with you and give any possible assistance in your drying problems.



Complete description of these new research facilities contained in Bulletin D-101—copy on request.



Main hot air duct and venturi; and (right) liquid collector and two powder collectors.

Top of drying chamber showing the exhaust duct leading to liquid collector in background.

SWENSON EVAPORATOR CO.
DIVISION OF WHITING CORPORATION
SPRAY DRYER DEPARTMENT, 221-M N. La Salle St., Chicago 1, Ill.
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18 months. Constructed for the manufacture of metallurgical coke, the Tacoma plant actually produced domestic coke because of a shortage of coal miners. During the war it had a yearly production rate of about 75,000 tons of coke, 900,000 gal. of tar and 1,000,000 cu.ft. of gas. Plant facilities include one unit of 17 regenerative-type, electrically-driven coke ovens in addition to various coal, byproduct and coke-handling facilities. According to reports, various byproduct chemicals will be recovered.

Texas Coke-Ovens Resume Operations

FOLLOWING arrangements for leases from War Assets Administration, Koppers byproduct coke ovens have been returned to operation in Texas at Sheffield Steel Corp. at Houston and Lone Star Steel Co. at Daingerfield. Production at the 47 ovens of the Sheffield plant, having a combined capacity of 276,000 net tons of coke per year, includes light oils, ammonium sulphate and coal tar. At the Lone Star plant, which has 78 ovens with a total capacity of approximately 360,000 tons of coke per year, products include light oils, ammonium sulphate, sodium phenolate and coal tar.

Magnolia Extraction Plant Begins Operations

LAST MONTH Magnolia Petroleum Co. put into operation its new $3 million plant near Vanderbilt, Texas, designed to extract propane, butane, and natural gasoline from casinghead gas produced in the Vanderbilt field. The plant, which is processing gas that was previously flared and wasted, is designed to handle 25 million cu.ft. of gas per day and produce from it a total of 40,000 gals. per day of propane, butant and natural gasoline. The byproduct dry gas will be utilized locally and also by the Magnolia Petroleum Co. refinery at Beaumont, Texas. Hudson Engineering Co., Houston, designed and built the plant in cooperation with Magnolia engineers.

West Coast Magnesium Unit To Serve as Pilot Plant

THE American Chrome & Magnesium Industries of New York has received authorization from WAA to operate the war-surplus $20,000,000 Mead ferrosilicon magnesium plant near Spokane, Wash., on a pilot plant scale. Under terms of a 90-day renewable option, the company will attempt to prove a new process for ex-

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CHEMICAL PLANTS.. cut costs with CLARK STEAM TRAPS. Large volume air removal gives quicker heating up action—saves fuel. Elimination of condensate permits rapid, full flow of new dry, live steam—extends life of equipment.

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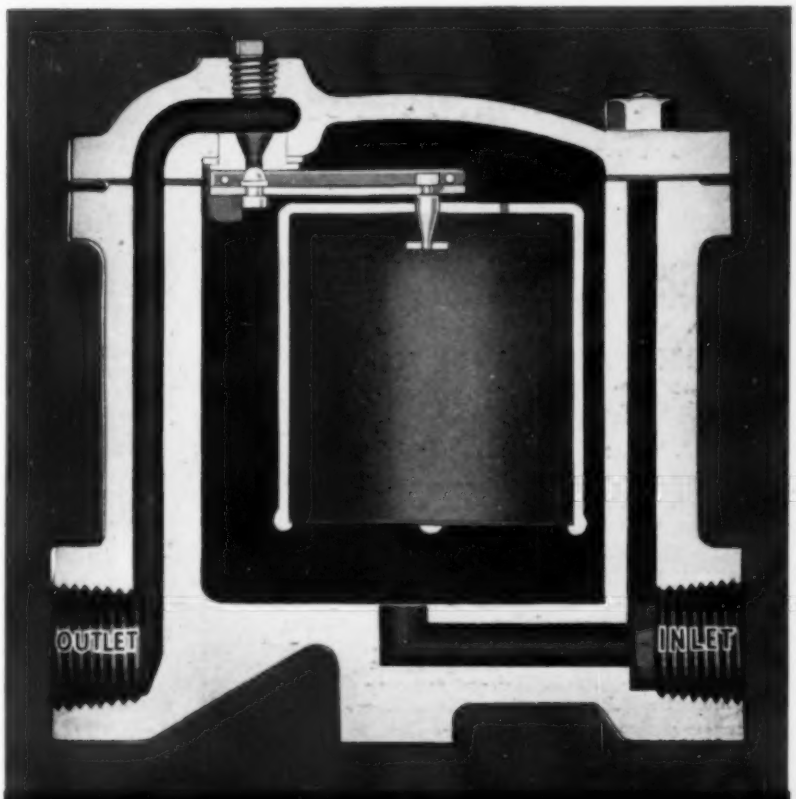

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STEAM AND FLUID TRAPS	STRAINERS	PRESSURE REGULATORS
VACUUM AND LIFTING TRAPS	VALVES	REDUCING VALVES

tracting magnesium from olivine ore, large deposits of which are controlled by the firm in the Twin Sisters area of Northwest Washington. Although its bid of $8,000,000 for purchase of the plant was previously rejected, WAA has indicated that if pilot plant costs can be held to 12-13 cents a lb., there will be no difficulty in arranging the sale. Use of the government-owned Rock Island ferrosilicon plant, near Wenatchee, Wash., for production of ferro-chrome was also included in the deal.

Designed to produce 24,000 tons of magnesium and 24,000 tons of ferrosilicon annually, the Mead plant has been the scene of much controversy as to its ultimate use. Since operation costs during the war at 50 percent capacity were never below 19.4 cents per lb., WAA has been cold toward use of the plant as a magnesium producer. If the new process is proven to be commercially feasible, however, it will become one of the two magnesium plants in the West and only one in the Northwest. Olivine deposits controlled by American Chrome & Magnesium are estimated at 2,500,000 tons.

Experiments Show Value of Coal Gasification

A recent experiment in the underground gasification of coal (see Chem. Eng., Apr. 1947, p. 107) conducted by the Alabama Power Co. and the Bureau of Mines, has demonstrated that the idea is feasible for commercial production of power, and possibly synthetic liquid fuels. This conclusion was reached recently by representatives of power and mining industries and scientists who were given the results of the experiments at a meeting in Washington.

Although the experiment was conducted under adverse conditions brought about be relatively little roof over the burning seam of coal, the "make" gas produced ranged from 50 to 221 BTU's calorific value. The light overburden resulted in loss of heat and pressure and in burnouts. A heavier cover over the subterranean gas-producer, supplemented by an increased air blast, would make production of a 150 BTU gas a simple matter, according to specialists who conducted the experiment.

Power experts attending the meeting pointed out that a gas of 150 BTU content would be sufficient for operation of a nearby power plant of considerable size. Oil technologists also estimated that further research might develop an entirely new concept in production of synthetic liquid fuels.

The next step, according to the con-

sensus of those who heard the results of last winter's experiment should be a thorough study of the economic possibility of a commercial-size operation involving a sizeable tract of land containing enough coal to sustain production for 20 to 30 years. Upon the results of the economic study will hinge the decision on further development of underground gasification.

It is understood that two somewhat similar tests are underway by private industry. One of the principal troubles encountered in the experiment developed when the slate roof over the burning coal became plastic and flowed down over the fire, endangering the air flow and control of the flame.

Two results of the experiment were particularly encouraging, according to experimenters. One was the fact that inspection of the burned-out area underground showed that the coal was burned clean, there was very little coke, and the ashes were where they belonged at the bottom of the shaft. The second encouraging result was that despite roof "flows" that appeared to clog entries, it was still possible to get comparatively free passage of air to the limit of the blower.

Texas A. & M. Will Hold New Instrumentation Course

SECOND annual short course in "Instrumentation for the Process Industries" will be conducted by A. & M. College of Texas at College Station during August 27-28-29. The program, incomplete a few weeks ago, will include a discussion of chemical control systems for the sea water bromine process. The 1946 course was attended by more than 200 men from engineering, technical and operating departments of companies in the Mid-continent and Gulf Coast regions.

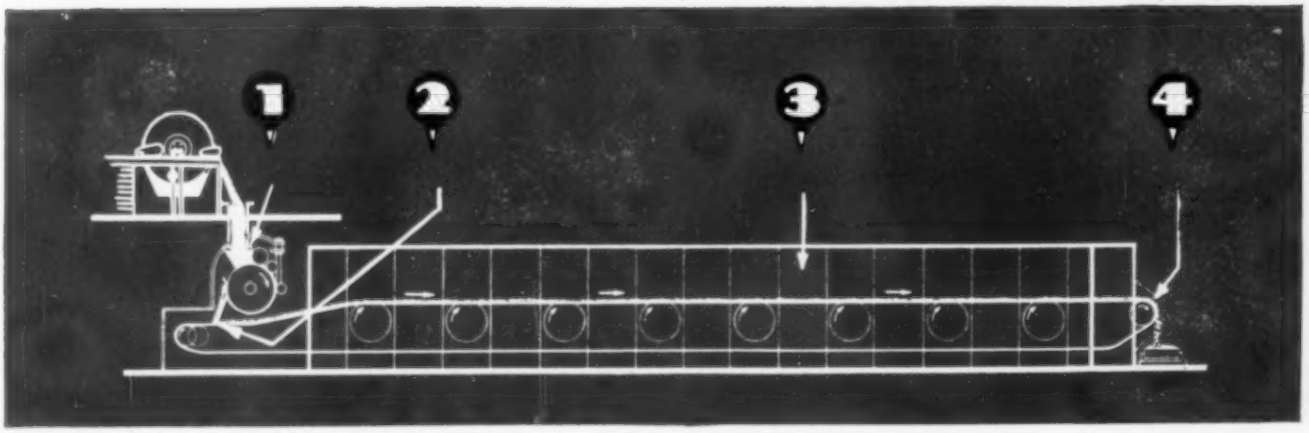
Detailed information may be obtained by writing Dr. P. G. Murdoch, Engineering Dept. A. & M. College, College Station, Texas.

Oregon Alcohol Plant Makes First Shipment

FIRST COMMERCIAL shipment of ethyl alcohol produced from the wood waste hydrolysis plant of Williamette Valley Wood Chemical Co. at Springfield, Ore., was made May 27, when 8,000 gal. was started for Chicago. The shipment was to U. S. Industrial Chemicals, Inc.

Only two of the five large percolators are now in operation at the $3,000,000 government plant, which will be operated under lease by Williamette Valley Wood Chemical Co., composed largely of Eugene lumber

Magnesium carbonate dried from moisture content of 565%* (B.D.W.B.) to 1.0% in 29 minutes



*This means 5.65 lbs. of water per 1.0 lb. dry material

in PROCTOR CONTINUOUS CONVEYOR SYSTEM

In one typical installation of a Proctor individually designed continuous conveyor system, for use in drying magnesium carbonate, here is what takes place: (1) Material with moisture content of 565% (B.D.W.B.*) is delivered to pre-forming feed of dryer, from a continuous filter (2) Coming to the hopper of the fin drum feed in this highly moist state, the material is pressed into the grooved surface of an internally heated, revolving fin drum. On this drum, the material is dried sufficiently to be discharged to the conveyor of the continuous dryer, in the form of small sticks of uniform thickness. (3) Loaded to uniform depth on the moving conveyor, the material is conveyed through the drying chambers where heated air at 290°F. is circulated *through* the bed of magnesium carbonate. By forming the material into small, uniform shapes, more rapid diffusion is possible, which accounts for rapid drying and uniformity (4) After only 29 minutes of drying time, magnesium carbonate, uniformly dried to a moisture content of 1.0% (B.D.W.B.), is discharged from the dryer at the rate of 500 pounds (C.D.W.†) per hour.

This particular application for one type of Proctor pre-forming feed, combined with a continuous conveyor dryer, illustrates just one installation. These systems are literally tailor-made to meet individual plant and product requirements . . . after careful research and study into the specific problem. If the drying of wet-solids is part of your operation, it will pay you to have Proctor engineers consider your problem. Write today.

†Commercial dry weight.

This is a case history taken from this new Proctor booklet

A new 12-page booklet on "Proctor Continuous Drying for the Chemical Process Industries" is available upon request. It contains many case studies showing the application for Proctor individually designed systems. Write for your copy of this informative booklet today.

PROCTOR & SCHWARTZ, INC. Philadelphia 20, Pa.

interests. In full production, the plant is expected to produce 10,000-12,000 gal. of industrial alcohol daily (for a description of the process, see *Chem. Eng.*, Oct. 1946, p. 172). Operation of the plant was delayed for months by lack of essential equipment which arrived only recently; full production will not be under way for several months. Overall production cost of alcohol at the new plant, first on this continent to use the wood hydrolysis process, is estimated by engineers at 30-35 cents per gal.

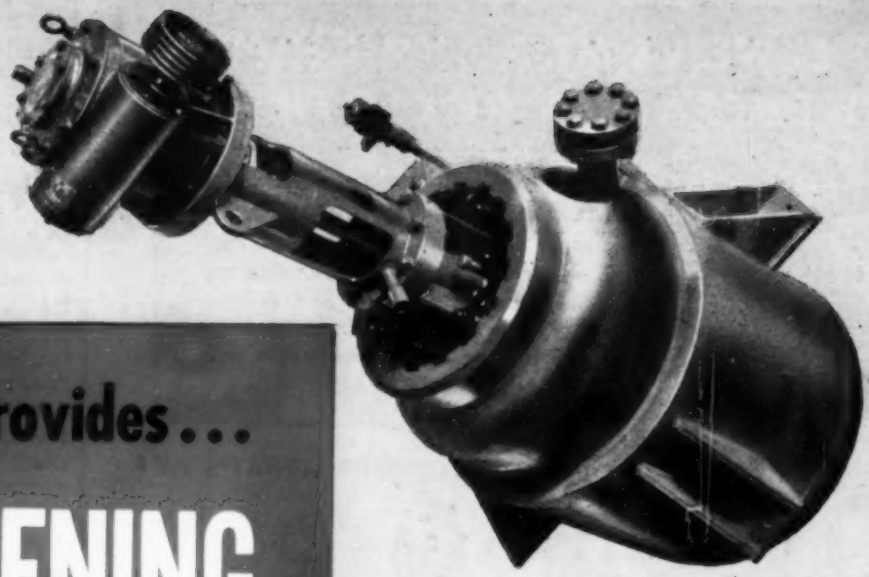
Research Institute Honors Charles A. Thomas

SECOND presentation of the Industrial Research Institute Medal was made to Charles Allen Thomas, executive vice president, Monsanto Chemical Co., at the ninth annual meeting of Industrial Research Institute on June 5 in Swampscott, Mass., for his pioneering and inspiring leadership in the development of the American industrial research system and for his participation thus in American chemical enterprise. In accepting the award Dr. Thomas warned that America can no longer look to scientists of other nations for basic scientific achievements but must stimulate the originality and creativeness of its own research to new and greater heights if the country's security in the atomic era is to be insured.

N. A. Shepard, Chemical Director of American Cyanamid Co., was elected president and E. W. Engstrom, vice president in charge of research of the RCA Laboratories, vice president for the ensuing year. C. L. Bausch, vice president of Bausch & Lomb Optical Co., and P. D. V. Manning, vice president in charge of research of International Minerals & Chemical Corp., were elected to three-year terms on the Board of Directors.

Plan Electric Furnace Units For Phosphate in Idaho

PLANS for a $5 million program to produce elemental phosphorus, phosphoric acid and concentrated superphosphate at a new electric furnace plant in Idaho have been announced by J. R. Simplot of Boise. Pilot plant operations on the process are now being conducted at the Wilson Dam facilities of the Tennessee Valley Authority in Alabama. If these confirm laboratory results, construction on the commercial Idaho plant, to be located 16 miles east of Fort Hall, will probably begin this year, with initial production anticipated by late 1948. Engineering work on the project is in



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Easy access to the interior of high pressure autoclaves and special pressure vessels, is made possible by Blaw-Knox Quick-Opening Closures.

These are especially desirable for cleaning and for inspection or changing of agitators, coils or other internal devices.

Blaw-Knox specializes in the design and construction of high pressure autoclaves of all sizes and types, and for all purposes. Autoclave units incorporating the quick-opening closures as illustrated can be furnished in standard sizes. When you are in need of an Autoclave—consult Blaw-Knox.

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progress, and certain machinery and equipment items have been ordered.

Present plant eventually anticipate four 15,000 kva. furnaces, each capable of processing 125,000 tons of rock and producing 50,000 tons of 47 percent triple superphosphate annually, it was stated by T. C. Butler, chief engineer of J. R. Simplot Co. In addition o fertilizer, the firm would produce elemental phosphorus and industrial H_3PO_4 of food-grade quality. Major market for the concentrated phosphate fertilizer would be in the intermountain, Pacific Coast and midwest states normally not supplied by southern sources. The new project will have no effect on Simplot's production of 18 percent single superphosphate at Pocatello.

Adequate supplies of coke, silica and electric power are available at feasible costs from nearby sources in private industry, it was stated. The phosphate rock charge would consist of phosphatic shales analyzing 22-27 percent P_2O_5 from the firm's present open-pit mines near Fort Hall. Exploration has also been conducted at phosphate beds in Caribou County north of Soda Springs. Preliminary drilling indicates an adequate supply of shale for 25 years of furnace operation.

Major Advances Made in Wood Utilization

COMMERCIAL production by Weyerhaeuser Timber Co. of five new products from processed bark, representing 12 percent of a saw log but hitherto only of limited value as a fuel, is a significant step toward more complete utilization of the valuable forest resources of the Pacific Northwest. The products are now being produced in a new and unique plant operated by the company at Langview, Wash. Although barks of all Pacific Coast conifers are usable, the plant is now operating on bark from Douglas fir. Maximum capacity of the plant on a 3-shift basis is some 75,000 lb. daily, states J. T. Rushton, general superintendent of production. The five products, having a wide present and potential application in industry, consist essentially of cork flakes, short fibers, tissue powder, a cork-fiber combination and a cork-fiber-powder combination. They are being marketed nationally under the general trade name Silvacon.

Processes which separate the bark ingredients were perfected by the Weyerhaeuser development department, set up in Longview in 1942 under the management of R. D. Pauley. Pilot plant production has been under way for a number of years. In the new four-story plant, covering

PROJECT NO. 35710

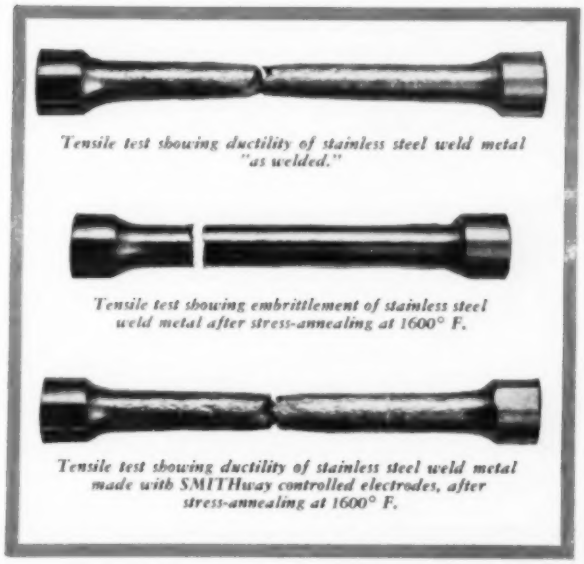
Weld brittleness eliminated after heat treatment of stainless steels

IN the welding of stainless alloys, commercial electrodes of the right chemical composition for each type of stainless alloy produce welds of excellent ductility, in the "as-welded" condition. Elongation in 2-inch gage length is usually in the range of 35 to 50%.

However, when it becomes necessary to stress-anneal welded stainless steel sections at temperatures of 1600° F., the welds sometimes become brittle and the elongation in a 2-inch gage length is reduced to less than 10%.

Extensive tests by the A. O. Smith welding research laboratory proved that the presence of excessive silicon (above 0.60%) in the weld metal was an important factor causing embrittlement. These tests further brought out the fact that, when the silicon was held to a maximum of 0.50%, consistently ductile welds resulted after stress-annealing and the elongation was increased to a value of 25 to 30% in a 2-inch gage length.

This critical problem, which limited the use of some stainless steels, was solved when the welding research laboratory adjusted the chemical ingredients of the electrode coating to balance the silicon content in the weld metal.



Tensile test showing ductility of stainless steel weld metal "as welded."

Tensile test showing embrittlement of stainless steel weld metal after stress-annealing at 1600° F.

Tensile test showing ductility of stainless steel weld metal made with SMITHway controlled electrodes, after stress-annealing at 1600° F.

This SMITHway combination of electrode development and manufacture for *SMITHlined* pressure vessels is a unique advantage to pressure-vessel users.

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New York 17 • Philadelphia 5 • Pittsburgh 19 • Atlanta 3 • Chicago 4
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WELDING EQUIPMENT • TURBINE PUMPS • PETROLEUM METERS • AND OTHER PRODUCTS

7,000 sq.ft. of floor space, a series of grinding and screening steps integrates the bark processing with the firm's new plywood mill. Bark from Douglas fir "peeler" logs used in the plywood plant is processed and part of one of the products (Silvacon 472) is then returned as an ingredient in the glue line. This product has been used since 1944 in the mills of Washington Veneer Co., Olympia, and Springfield Plywood Corp., Springfield, Ore. It is also used in match igniting compounds and as reactive ingredient in thermosetting molding compounds.

Resin Production Starts at Hercules New Jersey Plant

A MODERN new Hercules Powder Co. plant, for the manufacture of chemicals for the paint, varnish, lacquer, adhesives, and other industries has been officially opened at Burlington, N. J. The first unit of the plant to be brought into production was the one for the manufacture of pentaerythritol resins for protective coatings. Subsequently, units for the manufacture of liquid resins, rosin esters, and hydroabietyl alcohol, will be in operation. The plant is expected to be in full production the later part of this summer.

Tennessee Eastman Offers Engineering Fellowships

THE Tennessee Eastman Corp. will support six postgraduate fellowships in chemistry, chemical engineering and textile engineering during the scholastic year 1947-48 according to James C. White, president. Details of the fellowships are as follows: $1,200, Ph.D., chemistry, Brown University; $1,200, Ph.D., chemistry, University of Tennessee; $1,200, Ph.D., chemistry University of North Carolina; $1,200, Ph.D., chemistry, University of Virginia; $750., M.S., chemical engineering, Virginia Polytechnic Institute; and $750, M.S., textile engineering, Georgia School of Technology.

New Underground Natural Gas Storage Set Up in Illinois

THE National Tube Co., U. S. Steel subsidiary, is collaborating with the Public Service Co. of Northern Illinois in a project which provides for gas storage underground rather than in the conventional storage tanks above ground, and insures larger subterranean natural gas storage facilities in the years to come. Last fall the utility completed a pilot installation of subterranean gas storage at Kankakee, Ill., and has started on an installation on a 160-acre tract at Wolf and Foundry Roads at

"Pittsburgh"

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Unlocking the chemical treasure house of coal, and extracting and recovering its multifold components for the uses of science, industry and commerce, is the business of Pittsburgh Coke & Chemical Company.

Here modern plant facilities, earnest and foresighted research, favorable shipping location and advantageous sources of supply combine to assure you of dependable, uniform, quality chemicals.

Expanding volume and range of products and increasing capacities make *Pittsburgh* better able to serve you than ever. Our technicians will welcome an opportunity to discuss your needs.

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TAR BASES: PYRIDINE, PICOLINES
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Mount Prospect, Ill. At Kankakee the pilot plant has a capacity of 1,250,000 cu. ft. of gas, while at Mount Prospect the finished project will have a capacity of 40 million cu. ft.

Sections are fashioned from 24-in. seamless molybdenum steel pipe. Each of the completed pipe sections is 40 ft. long with a capacity of 25,000 cu. ft. at 2,240 lb. pressure. Pipe sections are buried underground. The utility company reports that underground gas storage has a lower cost of initial installation and a lower cost for operating and maintenance than the conventional gas holders so familiar in the American landscape. Another important point in favor of the underground system, the utility company said, is that since storage is in numerous small units, storage capacity may be added easily or any unit may be taken out of service for repair or inspection without disturbing others.

Atomic Energy Expansion Program Underway

FIRST great expansion of atomic energy facilities since the end of the war is just getting started. Replacement of now obsolete equipment, expansion of bomb-making plants, building of new laboratories has been delayed for nearly two years, though much of the work has been programmed since late in 1945. But in June AEC started to place contracts for expansion amounting to nearly $350 million.

The biggest part of the program is to provide improved and additional facilities for manufacture of bombs and fissionable material. This phase will cost about $215 million. No information has been released on facilities to be built, except for a $20 million scheme for converting the town of Oak Ridge, Tenn., from a temporary to a permanent basis. It's indicated that the new production facilities will be located at existing atomic sites—principally Richland, Wash., and Oak Ridge. For construction of research facilities, the AEC is getting ready to spend about $125 million. Complete new laboratories, each costing in the neighborhood of $20 million will be built as follows: Brookhaven lab on Long Island; Argonne lab at Chicago; the Knolls lab at Schenectady; Miami lab at Dayton; and a West Coast laboratory, probably at Berkeley. A smaller laboratory is to be installed at various universities.

In the main, AEC is not so much changing the elements in its program as revamping it to telescope the time factors on the direct military applications and to stretch out the time factors on civilian application. One

These *Bonderized* road signs show the way to finish protection and corrosion control . . .

Signs, hundreds of thousands of them, guide motorists along the highways that criss-cross the nation. Each sign, exposed through the seasons, is a weathering test in itself.

Many of these signs are Bonderized before painting. By actual experience, Bonderizing prolongs the service life by four or five times, saves money and materials for the departments using this standard corrosion-resistant paint base.

Be guided by these road and street signs to longer lasting fine finish. Find out how Bonderizing can protect and preserve the paint finish of *your* product. Bonderizing is positive, simple, easy to control, economical, and effective. Write today for full information.

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PARKER PRODUCTS CONQUER RUST

effect is to make atom work distinctly less attractive to industry. Industrial firms which go into atom work make a substantial investment of managerial and technical talent, if not of money. And they make it, so far, on a non-profit basis. Profitwise, they're gambling that they can cash in on an insider's spot when nuclear energy achieves commercial importance.

Against this background, Monsanto's decision to drop its management of Clinton is more comprehensible than at first appears from the explanation provided in a joint Monsanto-AEC statement. According to the statement, Monsanto wanted to transfer the Clinton projects to Dayton, Ohio, where the company has its own central research laboratory and where it is now building a new AEC facility—the Miami Engineer Works. Work at Clinton includes production of radioactive isotopes, chemical research, health-physics research, work on an atomic power-generating unit, and a training school.

When AEC was unwilling to approve the transfer, Monsanto asked the commission to find another operator. Monsanto will continue to run AEC's Miami works. Until a few weeks ago, no information had ever been released on the purpose of this project. In mid-May, in response to local protests against the dangers of an atom plant, AEC revealed that the laboratory would do basic research on chemical problems in atomics, would be completed early next year, and would have a staff of about 450 people(about half of them scientific and technical men.

Lone Star Cement Plans to Expand New Orleans Unit

INSTALLATION of more than $1 million in new facilities at the New Orleans plant of the Lone Star Cement Company is scheduled to be completed around April 1, 1948. Facilities being installed consist of a 385-ft. kiln, a large combination mill for raw grinding and a new finish grinding unit. Operation of the kiln, having a capacity of 2,000 bbl. per day, will bring the new capacity of the plant to 6,000 bbl.

Texas Chemurgic Council Expands Operations

OPERATION of the Texas Chemurgic Council on an expanded and permanent basis is slated to begin toward the end of July, with Austin, Texas, as headquarters. Organized about three years ago, the Council has not had the advantage of a full-time, salaried staff, but has been conducting a membership drive to obtain $50,000

BEWARE

OF MAD SHORT CIRCUITS...

Protect Your High-voltage Motors with LIMITAMP CONTROL

Limitamp quickly and easily brings these mad short circuits under control. In less than *one-quarter* cycle, Limitamp's EJ-2 fuses cut off a rise in current from a short, and clear it in one-half cycle—long before the fault current has time to harm the contactor or motor. Your plant's power system needs this prompt handling of fault currents, and you will avoid the risk of costly shutdowns that can result from *one mad short circuit.*

A STARTER AND PROTECTOR IN ONE CABINET

G-E Limitamp control consists of an air-break contactor (the motor starter), and EJ-2 fuses (the short-circuit device). They are mounted in separate compartments of one, all-steel cabinet. Air-break contactors are specially designed for hard duty. Operating experience has proved that they furnish dependable, long-lived, low-cost service with only routine inspection.

Because they operate in air, they eliminate the problem of handling oil. And tip life of air-break contactors is many times that of comparable oil-immersed tips.

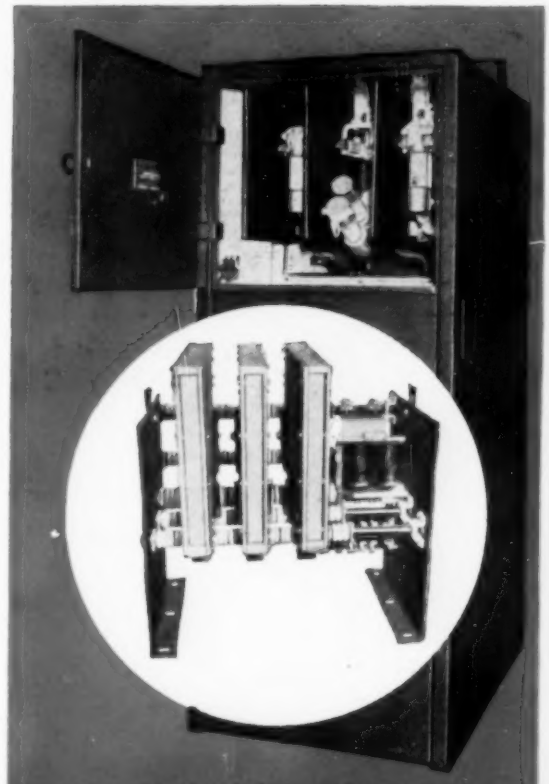
EJ-2 fuses are easy to replace, and they can't wear out. When you install a new fuse, you know your short-circuit protective device is in perfect condition.

OVERLOAD AND UNDERVOLTAGE PROTECTION

Isothermic overload relays, accurately calibrated against actual motor characteristics, guard the motor against overheating from sustained loads or single phasing.

FACTORY-ASSEMBLED CONTROL

Factory-assembled in one cabinet, Limitamp is easy to install, easy to co-ordinate with other control, saves space, and improves the appearance of your plant.



Limitamp control is furnished as a single unit, in groups, or in special enclosures for special operating conditions.

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Please send me Bulletin GEA-4247, describing Limitamp control.

Name .....

Company .....

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in order to establish this type of organization.

Objectives of the Council are to serve as a clearing house for chemurgic information, furnish members with facts relating to new chemurgic crops, create a chemurgic library at Austin, develop close contacts between producers of basic materials and the industrial consumers of such materials, and to maintain relationship with local, regional and national organizations in furthering chemurgic activities.

Victor H. Schoffelmayer of Dallas is president. E. B. Neiswanger of Corpus Christi is first vice-president, and Gilbert C. Wilson of Pittsburg, Texas, temporary headquarters of the Council, is secretary-treasurer.

Navy Sets up Organization For Nuclear Matters

NAVY Bureau of ships has established an internal organization for the handling of nuclear matters, including studies of the possible application of nuclear power to ship propulsion.

Three new sections of the Bureau have been set up by Vice Admiral Earle W. Mills, bureau chief, under a coordinator and deputy coordinator for nuclear matters. They are a radiological safety section, atomic warfare defense section, and nuclear power section.

Capt. Logan McKee and Capt. Albert G. Mumma were named coordinator and deputy coordinator for nuclear matters, respectively, and will function in dual capacities. They will coordinate all nuclear matters involving the Bureau of Ships. Capt. William S. Maxwell heads the radiological safety section. Commander J. M. Waters, USN, is in charge of the atomic warfare defense section, and Capt. Mumma, the deputy coordinator, also heads the nuclear power section.

New Insecticide Law Passed by Congress

COMPLETE regulation of the marketing and labeling of economic poisons and devices is provided by the Federal Insecticide, Fungicide, and Rodenticide Act passed by Congress this Spring. Effective immediately on signature by the President are many of the provisions, with the arrangement that some more difficult of immediate application take effect after six months or one year.

The new law includes all classes of substantially all materials used for pest control, with provision for registry with the Department of Agriculture of each commercial type and labeling in

accordance with detailed provisions to prevent fraud and to minimize public hazards.

Administration under the Secretary of Agriculture will be initially by the career staff of the Department, which has functioned under the old law. Increases in staff are anticipated because the new provisions will require more extensive operation and inspection. The bill as passed will be, according to industry spokesmen, entirely workable if administered in the spirit of cooperation between Government and manufacturers. Such cooperation is confidently expected in Washington because the bill has had cordial support from both the Department and the industry while before Congress.

Industry Briefs

Pennsylvania Salt Mfg. Co. has under construction at its Wyandotte plant additional boilers and allied power generating equipment, including a completely new modern power plant building, at a cost of more than $3.5 million. The new boilers and power equipment will be completed during 1948. Engineers and constructors for the new plant and equipment are Ford, Bacon and Davis, Inc.

Freeport Sulphur Co. has formed a subsidiary, The Micronizer Co., to engage in grinding materials to extremely fine particle sizes by a process known as "Micronizing." The new subsidiary has purchased the assets of International Pulverizing Corp., and affiliated companies, including American Pulverizing Corp., Micronizer Processing Co., Inc., and Micronized Products, Inc. It will operate existing plants at Moorestown, N. J., and Charlotte, Mich., and will grind sulphur for agricultural use, organic insecticides, inorganic pigments, pharmaceuticals and other materials.

READERS' VIEWS and COMMENTS

Disagreement

To the Editor:

Sir:—We are not in agreement with the claims as set forth in Allen S. Smith's article, "Rectangular Coordinates for Three Variables," which was presented in the March issue of *Chemical Engineering*.

Mr. Smith claims, without reservation as to systems employed, that when using his graph, all tie lines converge at a point and any line drawn from this point through the

THE PLANT BEHIND THE PRODUCT

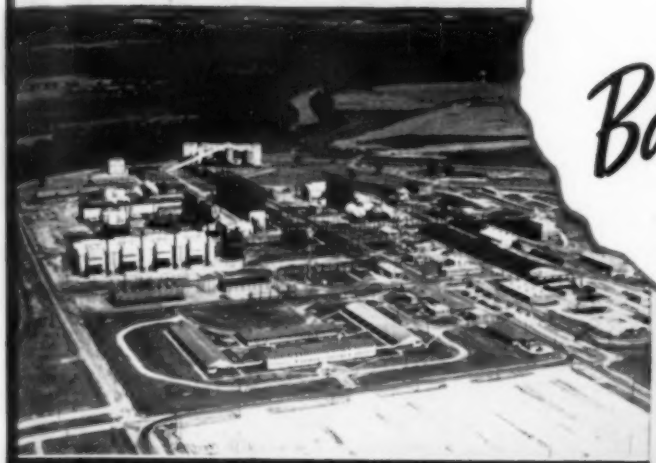
Newest Equipment
Newest Techniques

For Manufacturers of

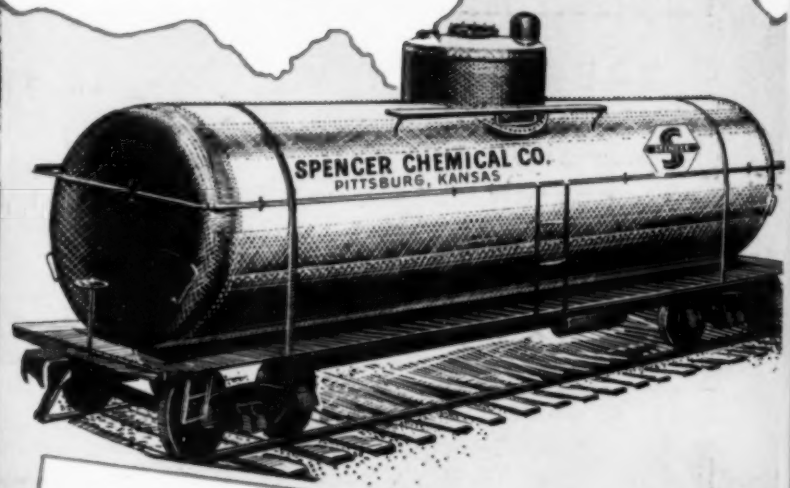
Basic Chemicals

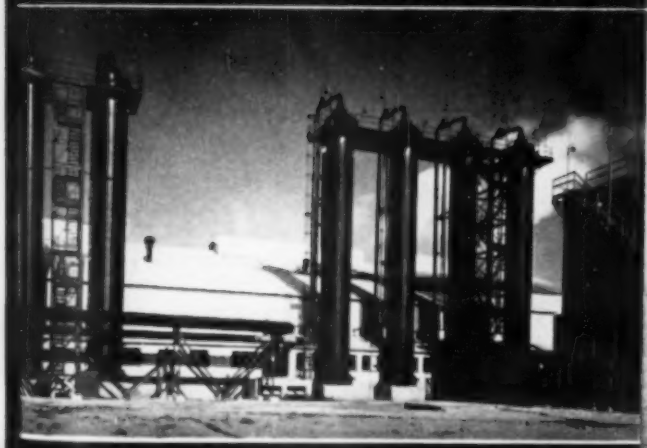
★ PITTSBURG, KANSAS

CENTRALLY LOCATED TO SERVE ALL U. S. A.



AIR VIEW OF SPENCER'S NEW WORKS AT PITTSBURG, KANSAS, LOCATED IN THE GEOGRAPHICAL CENTER OF U. S. A.





SECTION OF WATER SCRUBBERS

VIEW OF THE "AMMONIA LAB"

This Great New, Central Source of NH_3 and Aqua Ammonia Is Days and Hundreds of Miles Closer

Maintaining an orderly, even rate of production and scheduled delivery of basic materials . . . is vital to assure continuing 1947 profits against higher wages and costs!

The vast new, war-proven Spencer Works is prepared to make direct tank-car shipments, as scheduled. Spencer's central location expedites delivery . . . assures an even, economical rate of production. It is practical to schedule orders well ahead. Write, wire or phone today.

Spencer Chemical

SPENCER COMPANY

General and Sales Offices: Dwight Building, Kansas City 6, Missouri

Works: Pittsburg, Kansas

diagram is a tie line. He states further that when using his method, numerical calculation can replace graphical solutions of extraction processes, and that only one equilibrium measurement suffices to define the entire system of tie lines. His claims were exemplified, however, using a system similar to the acetic acid, water, chloroform system, in which two of the components are practically immiscible.

In the petroleum industry, we are frequently confronted with extraction processes in which two substances that are miscible in all proportions are to be separated by the use of a selective solvent that may be partially miscible with both. An example of such a system is the aniline, methylcyclohexane, *n*-heptane system. Here, mixtures of methylcyclohexane and *n*-heptane may be separated by use of the solvent (aniline in this case) which is selective for the methylcyclohexane.

If his claims are applicable, and if the tie lines are to intersect at a common point when using his method, they must also intersect at a common point on the conventional ternary diagram, and this point must be at the apex of the triangle (the apex here representing pure aniline). Now, if all the tie lines did intersect at the apex of the triangle, the solvent would not be selective for either component, the separation of the components by liquid-liquid contacting would then be impossible, and there would be no need for any type of calculation.

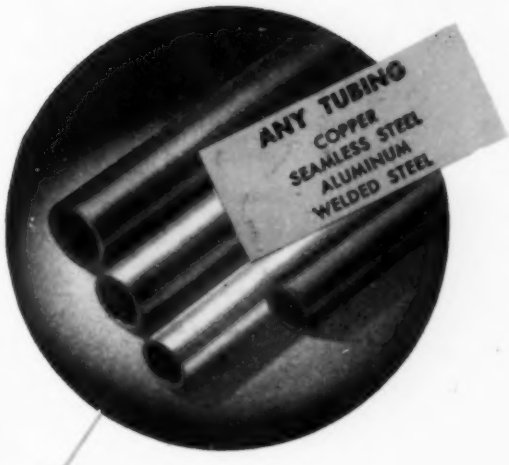
These conditions, of course, are repudiated by the facts. The separation of these components is possible by liquid-liquid contacting since the solvent is selective for the methylcyclohexane. The tie lines do not converge at the apex, but all (excluding the binaries) do intersect the line representing the binary of methylcyclohexane and aniline at various points, depending upon the selectivity. Finally, one tie line is not sufficient, to define an entire system of tie lines, and we are aware of no accurate method of predicting them.

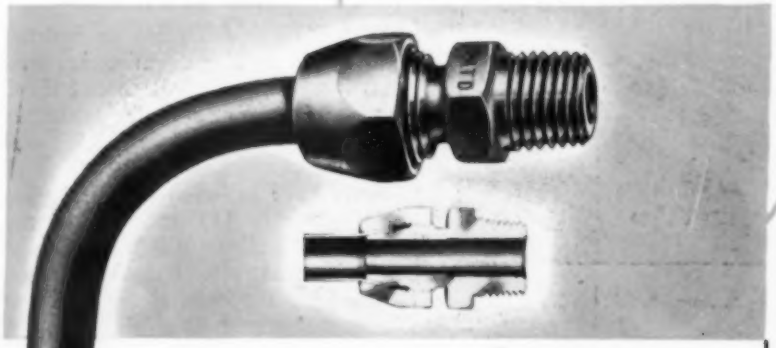
CHARLES F. BETHEA
GLENN H. DALE
ROBERT M. TWITCHELL
Bartlesville, Okla.

And Reply

To the Editor:

Sir:—Messrs. Bethea, Dale and Twitchell take exception to my statements: (1) That all the lines converge at a point, and (2) that one tie line suffices to define the entire series of tie lines. They apparently also





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question the statement that numerical calculation can replace grapical methods but do not discuss this. Therefore, I shall comment only on the former statements.

Statements (1) and (2) hold for systems containing one pair of immiscible components; such a system as indicated in the published illustration. They do not hold for systems containing two pairs of immiscible components. It is obvious that in this case the point of intersection would have to be an apex of the triangle and, as these men point out, this is contrary to fact for known systems. Messrs. Bethea, Dale, and Twitchell are perfectly correct in taking exception to my statements (1) and (2) if applied to systems with two pairs of immiscible components. They are not correct if exception is taken to these statements as applied to systems containing one pair of immiscible components. I should have included this limitation of statements (1) and (2) in my note. I regret that this was not done in the interest of accuracy and clarity, although the purpose of the note was to present a method of plotting as an original contribution.

The common point of intersection of tie lines on the conventional triangular graph was discussed by D. N. Tarasenkov [*J. Phys. Chem.*, (U.S.S.R.) **14**,589 (1940)]. He stated that it was possible to use one tie line to find the composition of any pair of solutions in equilibrium, and that a common point of intersection was a criterion of accuracy. He investigated six systems with one pair of immiscible components in the article mentioned, and additional systems in subsequent articles. I have checked numerous systems and am in agreement with his statement that deviations of the common point from a mean are due to errors in determining the tie lines. In other methods of tie line correlation where straight lines are obtained to represent equilibrium concentrations in two phases, the data are smoothed. It is my experience that the mean common point is as good as the smoothed line. If two points can be used to define a system of tie lines with a straight line plot [cf. Othmer and Tobias in *Ind. Eng. Chem.*, **34**,693 (1942)], then one point is adequate by the use of the common point of intersection method. Obviously, the two points and the one point must be located from accurately determined tie lines for two mixtures and one mixture, respectively, to use so few points.

As the writers of the letter state, there is no method of predicting tie

lines. There are methods for correlating data. In any correlation, systems with one and with two pairs of immiscible components must be treated differently in order to obtain general correlations. The two types of system differ as do dilute and concentrated solutions in their properties. I have obtained general methods of correlation, and have also applied the suggestions in my note with respect to the use of the lever arm relationship, and the possibility of numerical calculations. It is not possible in a small space to detail the applications or limitations. My experience and that of others has indicated the method of plotting to be of value. In general, it is not desirable to use the triangular type of diagram for extraction calculations in systems with two pairs of immiscible components; better methods are available.

I regret that the note did not restrict the statement concerning the common point of intersection to those systems having one pair of immiscible components. The comments in the letter are justified to that extent. To be complete, the statement should be further restricted to eliminate those exceptional systems with one pair of immiscible components in which the solvent is selective for one component in concentrated solution, and selective for the other component in dilute solution.

ALLEN S. SMITH
Professor of Chemical Engineering
University of Notre Dame
Notre Dame, Ind.

For Biochem. Engineers

To the Editor:

Sir:—Your editorial on "The Case for Biochemical Engineering," in the May 1947 issue was of particular interest to us here in Madison. It has now been over a year since we organized a course in Biochemical Engineering at the University of Wisconsin. Thus far we have given it no national publicity, but our recent University catalog contains some brief notes on our curriculum, together with an outline of the five-year course.

It is quite natural that we should develop such a course at Wisconsin because of our strong agricultural interests and because of the standing and ability of our Depts. of Biochemistry and Bacteriology to provide the required biochemical and bacteriological training. Our Department of Agricultural Chemistry was organized in 1883. The name was changed to the Department of Biochemistry about 1936. Chemical Engineering was formally organized at Wisconsin in

1905, and Biochemical Engineering in 1946.

The curriculum in Biochemical Engineering originated as the result of the persistent demands from industrial groups within the state. Our President, Dr. E. B. Fred, has long been a proponent of this type of training—perhaps by virtue of his own preeminence in the field of bacteriology. Wisconsin secured its reputation in the field of biochemistry through the publications of Professors E. B. Hart, Harry Steenbock, C. A. Elvehjem, W. H. Peterson and Karl Paul Link.

It is my understanding that at Wisconsin we are offering the first formally organized curriculum in Biochemical Engineering, at least one bearing that name. This, incidentally, has encountered some opposition among chemical engineering educators. However, from my own industrial experience, I am convinced that this course is fully justified and that without training in biochemistry and bacteriology no chemical engineer is competent to carry on extensive work in the food and fermentation industries.

No possible shuffling of the courses or training offered in the standard four-year course in Chemical Engineering will enable a graduate to handle problems where biochemistry and bacteriology are involved. In this respect our course is not a specialized branch of chemical engineering but a distinctly new one.

We have withheld giving much publicity to this course, awaiting the verdict of some of our colleagues in chemical engineering. Your editorial strengthens our conviction that we are right in this proposal.

O. A. Hougen
Professor and Chairman
Department of Chemical Engineering
University of Wisconsin
Madison 6, Wis.

We congratulate Wisconsin for this brave pioneering which seems to have anticipated our editorial suggestion by a whole year. We have also learned that other schools are toying with what seems to us a less desirable idea of a four rather than a five or six year course. In any event, the need is real as evidenced by a letter from the research director of one large manufacturer of pharmaceuticals who writes: "Needless to say, I am very much in agreement with your editorial and if you happen to receive any comments from people who either have such dual training or in the process of acquiring one, I hope you will let them know that there is at least one organization which can use their services."—Editor.

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Perchloric Acid Precautions

To the Editor:

Sir:—A recent serious explosion in a plant employing perchloric acid in an electrolytic process emphasized the danger inherent in handling this reagent. Hoping that others having experience with perchloric acid will be encouraged to contribute data for publication, Mallinckrodt Chemical Works, St. Louis 7, Mo., offers the following excerpts from its plant rules on perchloric acid.

The analytical uses of perchloric acid are well known and are not unduly hazardous in competent hands.

Hazards from perchloric acid apparently arise from its powerful oxidizing property and from what seems to be the spontaneous explosiveness of mixtures containing the acid or its compounds under conditions which cannot now be specified exactly. Both concentration and quantity of acid affect the hazard. There may, of course, be other hazards not yet defined.

Although complete evidence in matters of this kind is difficult to establish, violent explosions in handling perchloric acid have usually been traceable to mixing perchloric acid with some organic compound or to the presence in it of an organic body (such as alcohol) capable of forming an ester with the acid. Such mixtures are, we believe, highly hazardous and should be scrupulously avoided. The suspicion born of our experience is that the greatest danger from explosion comes from organic compounds which can form esters with perchloric acid or which are completely miscible with perchloric acid.

D. H. Killefer
Mallinchrodt Chemical Works
St. Louis, Mo.

Precautions in Handling Perchloric Acid in Quantity

The following rules are those adopted in our plant to compel the respect of workmen for perchloric acid.

Perchloric acid is a powerful oxidizing agent and can be extremely dangerous. Contact with the skin will produce bad burns. Any operator who must handle this material in plant quantities must be provided with personal safety equipment, including rubber gloves, rubber sleeves, a rubber apron and rubber boots. In addition, he should protect his face with either an eye shield or anti-splash goggles. Any of this material spilled on the floor should be promptly washed down the sewer with a great deal of cold water.

Fire Hazard—When mixed with organic matter, perchloric acid is violently explosive. Every precaution must be taken to avoid spilling or splashing it on anything combustible. Bulk stocks or carboys of the acid must be stored only in a fire-

proof building having a concrete floor equipped with a floor drain.

In the event of fire involving perchloric acid, every means should be used to keep it cold by means of a water spray. If the material is leaking from the containers, every available means should be used to keep it away from combustible materials of every kind. If perchloric acid has been spilled on combustible material and a fire has occurred, always assume that an explosion may follow and act accordingly.

Storage—Bulk stocks of perchloric acid must be stored in a fireproof building, remote from combustible materials, and should be kept reasonably cool. Regular inspection should be made to detect contaminated stock promptly for immediate removal and disposal. Any material spilled on the floor should be washed down the sewer promptly with plenty of cold water.

Inspection of Stock—A routine inspection is made at regular intervals of all perchloric acid stocks. A chemist inspects all shelf stock in the warehouses and laboratory stockrooms and examines with a glass sampling tube all carboys or bulk stock in storage during the first three days of each month. The chemist will oversee the immediate removal of any discolored stock and dispose of it according to the standard procedure. The laboratory must be notified immediately by foreman or operators finding discolored perchloric acid in the course of their duties in order that it may be discarded if necessary.

This routine has been established as a precaution against accidental contamination of perchloric acid and the accumulation of aged and discolored acid; this has been reported to explode spontaneously.

Waste Disposal—Perchloric acid that has become contaminated and is discolored should be disposed of as follows: Pour the contaminated acid into ten times its volume of cold water in a porcelain or glass vessel. Stir and then pour down the acid sewer. After material has been poured out, flush any spillage away and down the sewer with more cold water.

First Aid—Flush promptly with large volumes of water. Report to foreman at once. Other first aid of any kind is given in the plant infirmary. The hazard to workmen resembles that of sulphuric acid but perchloric acid burns are reported slower to heal.

Correction

An unfortunate group of transcribing errors has been pointed out by James T. Costigan in the article on Centrifugal Costs on page 123 of our May 1947 issue. Referring to operating costs of Sharples high-speed centrifugals a decimal point was transposed in transcribing material supplied by Mr. Costigan, with the result that the data given are 100 times too large. The equipment costs are correctly presented but the operating cost for transformer oil should be 0.02 c. per gal., rather than $0.02, while the correct figures for separating amyl acetate are 0.02 to 0.03 c. per gal., and for tar, 0.10 c. per gal.

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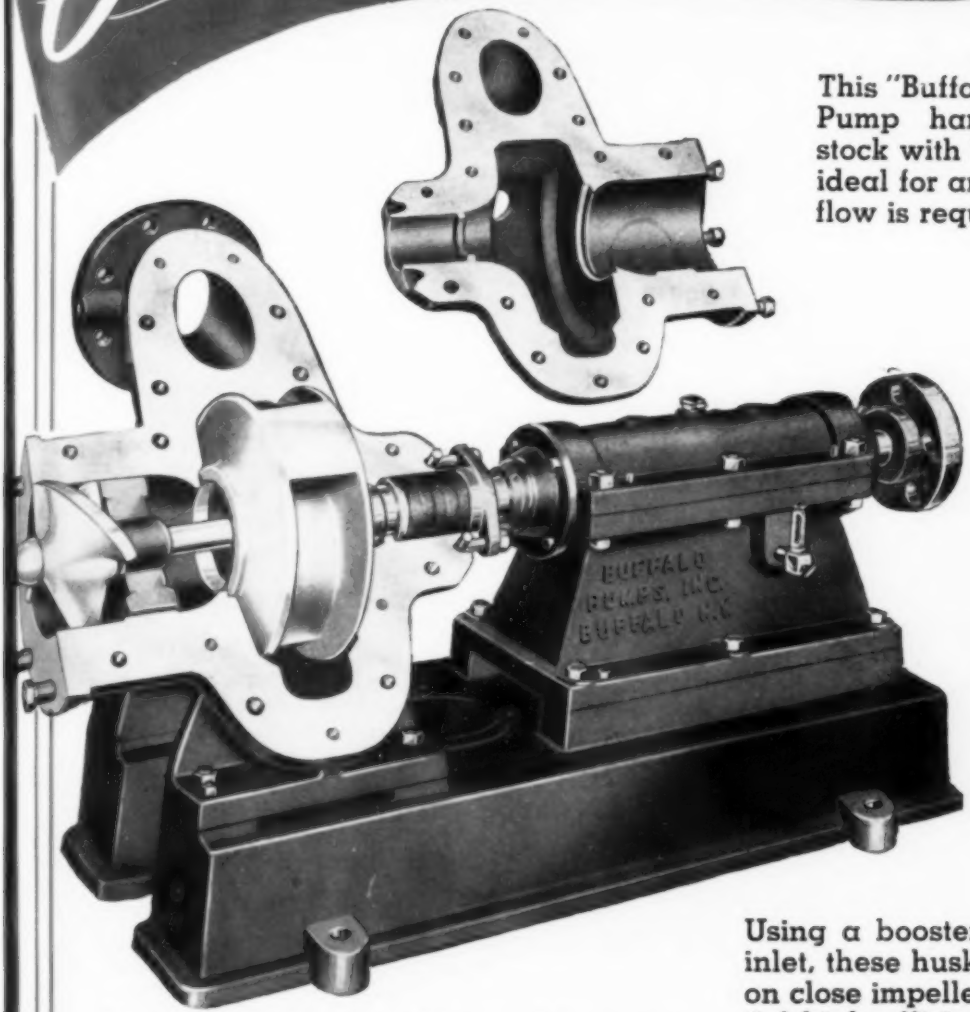

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NEWS FROM ABROAD

Special Correspondence

BRITISH PRODUCERS OF PETROLEUM CHEMICALS SEEK NEW CONSUMING OUTLETS FOR THEIR PRODUCTS

REALIZATION of the fact that the repercussions of the coal shortage were particularly severe in the chemical industries has caused authorities to give special consideration to chemical manufacturers in fuel allocations and permits for alternative sources of energy. As a result, the supply position has improved rather more rapidly than anticipated, and during June most consumers received prompt delivery of their essential requirements. Meanwhile, however, prices tend to harden, and a number of increases are expected for July.

A detailed review shows a striking improvement in the supply of potassic and phosphatic fertilizers, largely due to large arrivals of potash salts and crude phosphates from continental Europe and the Mediterranean area. Nitrogenous fertilizers still are in a tight position, partly because of continuing heavy export demand, and the supply of alkalis is only just keeping in step with growing consumption. Any, even a short-lived, interruption of the regular flow of supplies would cause serious inconvenience. There also has been a distinct recovery in the output of coal-tar products of which some, including cresylic acid and naphthalene are released for export, though in small quantities only.

The coal output has been held on the May level, and though some slight falling-off must be anticipated during the next few months owing to the holidays, the situation in the coal mining industry looks more promising than for a long time. Certain stocks are now being laid in for the next winter, and arrangements have been made for importing coal from the Ruhr, Poland and, of course, the United States. Boiler conversion to oil fuel ultimately will bring the share of liquid fuel up to 10 percent of all energy sources used in Britain, as compared with 6½ percent at present, but the original conversion program has turned out to be too ambitious. Further conversion permits will be granted in exceptional cases only, so that the maximum saving of coal will be no more than 10,000,000 tons a year, and this goal will not be reached before 1949. An annual saving of 8,000,000 tons is to result from coal-oil conversion by the middle of 1948, and smaller quantities will be saved during next winter. Conversion to oil fuel is thus no panacea for the country's power problem; even if successful in all cases and supplemented by a coal import program of necessarily limited proportions, it cannot take the load off the shoulders of the British mining industry.

Container Shortage

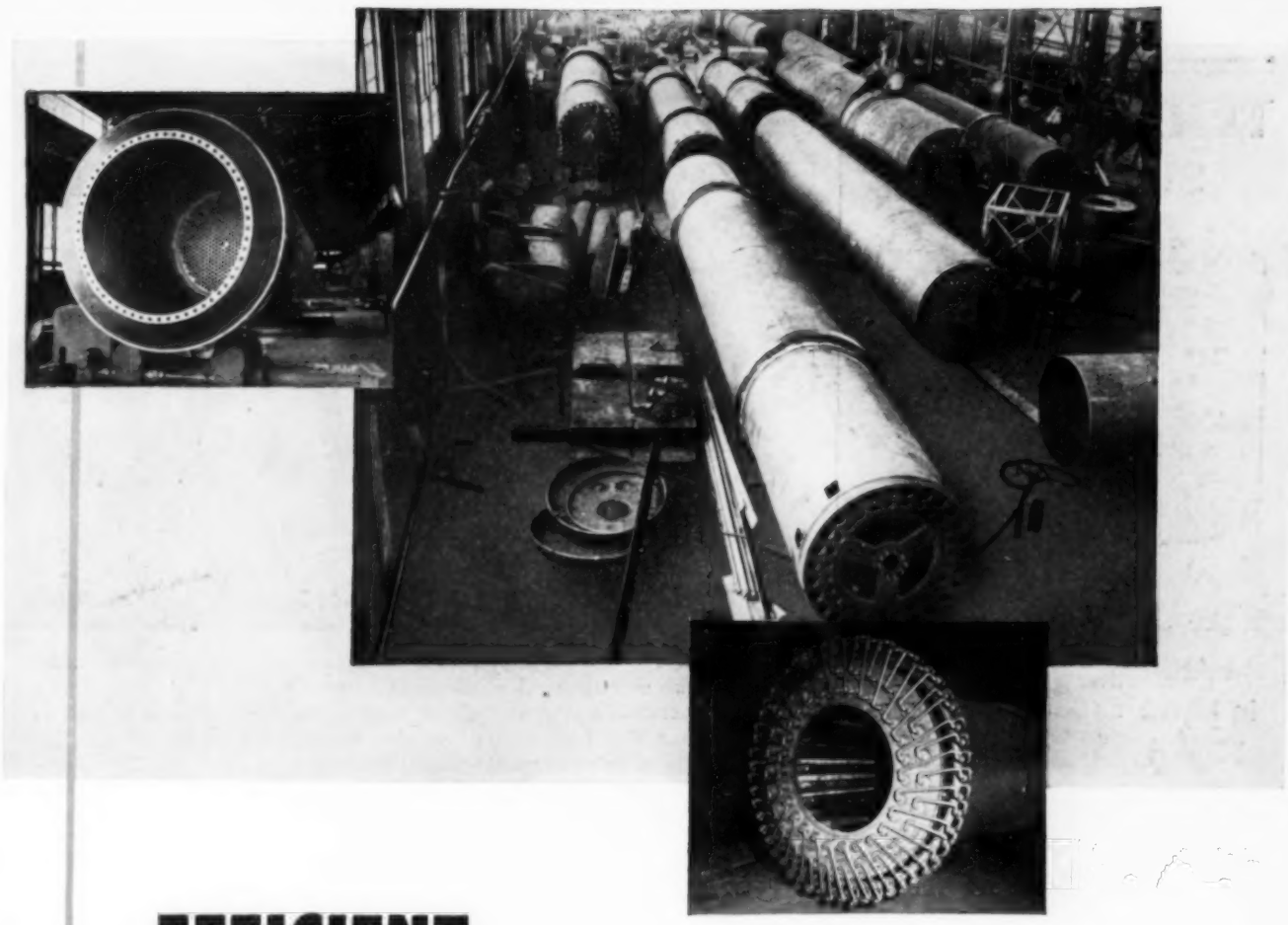
A shortage which still hits all chemical manufacturers is that of containers —drums and carboys for heavy products and small tins, jars and glasses for light chemicals. The supply of chemical specialties has improved notably of late, so much so that manufacturers dependent on small quantities of fine chemicals are no longer held up by delays in delivery of such ancillary products as happened earlier this year. A shortage which is likely to continue is that of carbon black. The inquiry committee has presented its interim report to the Board of Trade from which it appears that "plans for the production of carbon black in Britain are being explored." The Anglo-Iranian Oil Co. has been approached with a view to the erection of carbon black plant in Iran. Meanwhile, however, motor tire makers are working short time because carbon black supplies from North America are inadequate.

Pending completion of the petroleum chemicals plants now under construction in various parts of the country, exploratory steps are being taken by prospective manufacturers to develop markets for their new products. Petrochemicals Ltd. has announced its plant is expected to commence operations in mid-1948. Production will include pure grade and nitration grade benzene and toluene; 3 deg. C. and 5 deg. C. xylenes; alkyl benzenes; purified white naphthalene; methyl, dimethyl and trimethyl naphthalenes; high purity anthracene, phenanthrene, pyrene, chrysene, acenaphthene and fluorene; pitch for electrode coke; ethylene and propylene derivatives and intermediates, including anhydrous ethylene chlorhydrin, ethylene oxide, ethylene glycol, ethylchloride, ethylene dichloride, and isopropyl alcohol and acetone; butadiene, butenes and derivatives.

Some of these as well as other chemicals also will be made from a petroleum basis by the Shell Petroleum Co. at Thornton-le-Moors, Cheshire, from next year onwards, while other products on the Petrochemicals list already are available in limited quantities from the Beckton byproducts works of the Gas Light and Coke Co. This company is isolating fluorine, quinoline, acenaphthene, beta-methylnaphthalene and ethyl cyanide as well as a number of other specialized products required by makers of vitamin tablets, photographic chemicals, etc. and for use as solvents.

Demand for specialized products to meet certain specific requirements some of which have arisen only recently accounts for a number of new production schemes which, though individually of limited importance, are worthy of special note because they add to the diversity of products supplied by the British chemical industry and promise to add to its export sales, making up for any recession in shipments of bulk chemicals. Some of these owe their success to the shortage of natural raw materials. Synthetic detergents, non-toxic refrigerants, oil additives for lubricating oils, photographic developers, catalysts for artificial ageing of perfumes and spirits, selective agents for the purification of oils, waxes, resins, etc., oils for liquid and vaporphase heating, and glycerine substitutes are among such new specialties.

Special attention has been devoted to materials of use in agriculture and for building. A large and growing range of insecticides, fungicides and weedkillers is being placed at the disposal of farmers, and recent research has resulted in the development of a number of important selective pest-control agents the commercial utiliza-



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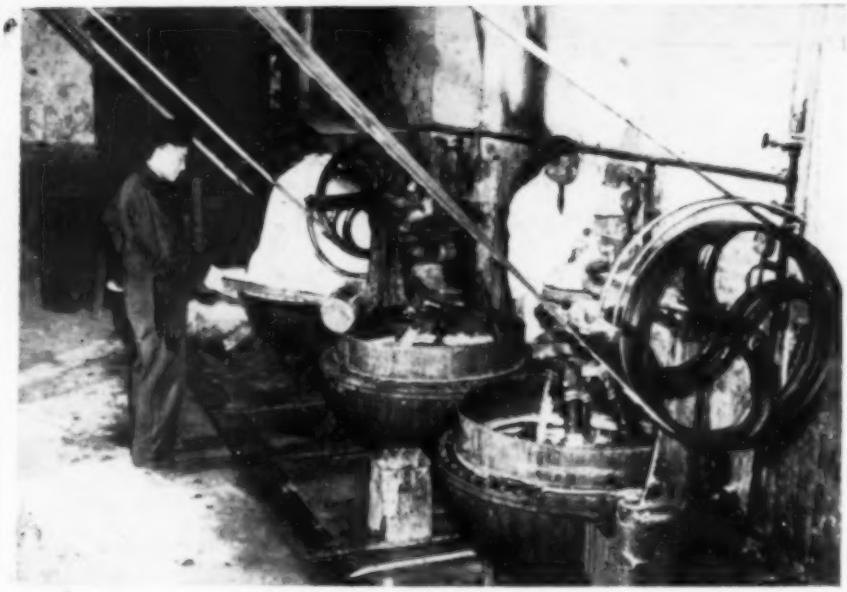


Caustic soda for use in emulsifiers for insect-killing sprays, is made in the national pesticides manufacturing plant in Shanghai, China. The vats in picture are part of the equipment from a plant formerly used as a Japanese leather factory. Machinery has been improvised from salvaged machines or made from scrap material. Insect poisons made in the plant are distributed throughout China by UNRRA as part of its agricultural rehabilitation program. Dr. H. S. Chen, center, young American-trained Chinese chemical engineer, developed the acid calcium arsenate powder produced there

tion of which, however, is held up by delays in plant construction.

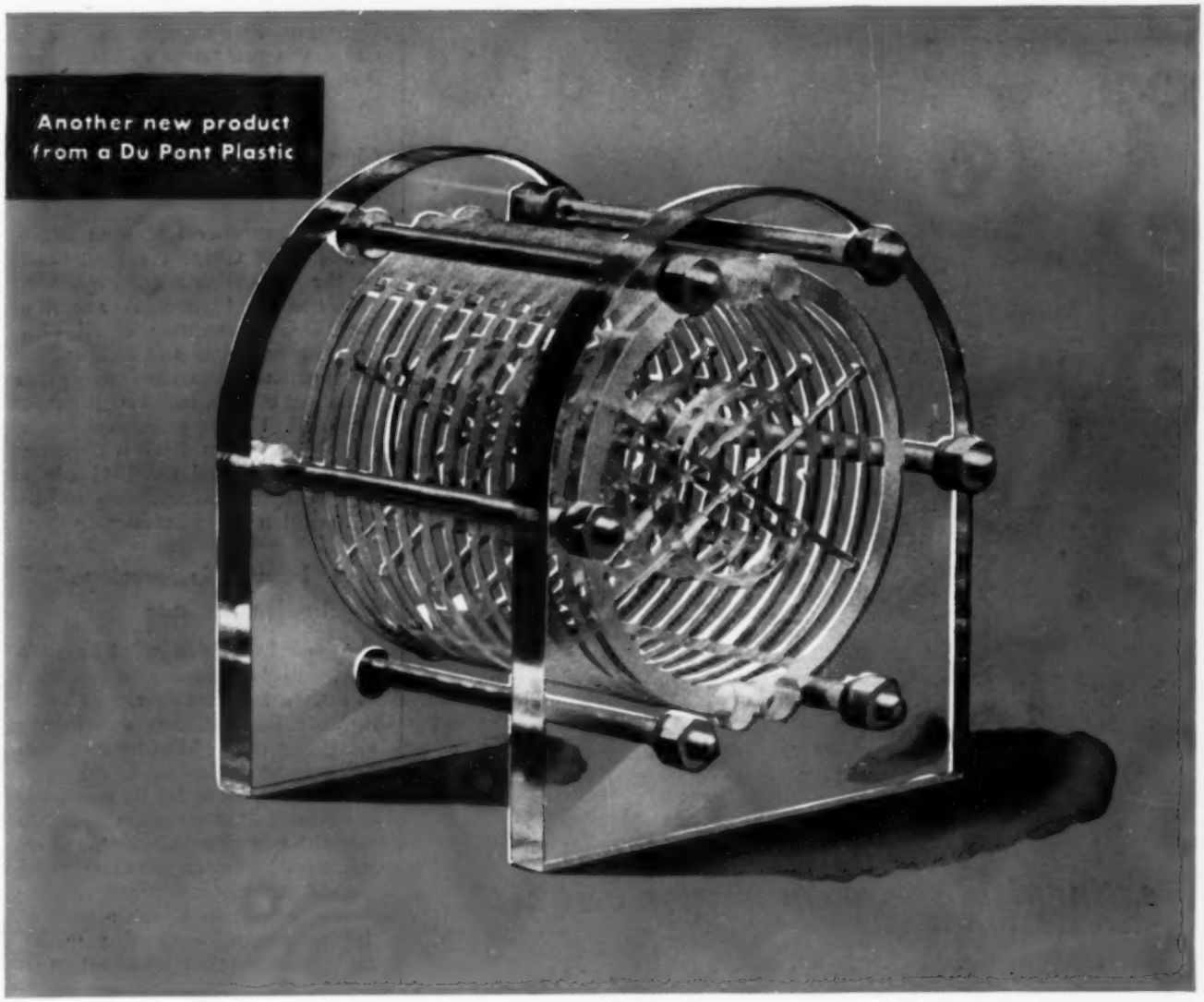
For the building industry chemical manufacturers have supplied a number of products of use in the erection of prefabricated houses, and some of these are now being studied with a view to their application to permanent building. The linseed oil shortage has caused the biggest paint manufacturer in the country to split non-drying and semi-drying oils, which formerly were of little value to paint technology, into two or more fractions "one of which, and generally the largest fraction, produces drying oils fully equal to the normal performance obtained with linseed and, in some cases, with new and highly desirable qualities in which linseed oil itself is singularly lacking."

The plastics industry is also profiting from the shortage of natural raw materials, but owing to the lack of certain basic products it has hardly been able to make full use of its opportunities while it is feared that when the supply position improves many of its present customers will switch over to other raw materials. The shortage of flooring materials, timber and fiberboard has given a stimulus to the use of thermoplastic materials in conjunction with other products for linoleum substitutes, wall boards, etc., and the poor outlook for lead supplies also has led to increased use of plastics in the cable industry.

In view of the more liberal supply position of rubber reflected by the decline in world market prices special interest attaches to schemes for increased use of rubber products. The Dunlop Special Products Ltd., formed last year, has concentrated on the development of compounds and dispersions and of a wide range of components and equipment for the engineering industry, but progress is temporarily restricted by delayed deliveries of essential machinery. Hopes are based on the use of new synthetic materials, such as flexible synthetic resins, embodying rubber, and good progress has been made with a plant for decorative tiles on a rubber basis which, it is announced, will be in production before the end of this year.

Australian Alkali Plant Will Be Expanded

AN EXPANSION program has been favorably acted upon by the Imperial Chemical Industries of Australia and New Zealand whereby its alkali plant at Osborne, South Australia will be expanded at a cost of more than $3,250,000. Capacities will be doubled for soda ash, caustic soda, bicarbonate of soda, and calcium chloride, thus bringing total output up to 100,000 tons a year. Projected extensions involve opening of a new limestone quarry and extension of salt fields which at present cover an area of five square miles.



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...THROUGH CHEMISTRY

Output of salt is expected to be 200,000 tons a year but it will take more than two years for completion of the entire program.

Chemische Zentralblatt Again Available

IN AN announcement from Berlin, publishers of Chemische Zentralblatt say the publication is again appearing in its traditional format. As a result of the official assumption of all copyrights, manuscripts and archives, the continuation, without any ommissions, to the last edition, including the index is assured. The announcement further says that the year 1947 is appearing from April on and the 1945 edition may be supplied immediately and the 1946 edition somewhat later.

New Insecticide Developed By Russian Institute

A NEW insecticide called hexachlorane, strongly poisonous for practically all insects, has been developed by the Institute for Fertilizers and Insecto-Fungicides of the Ministry for Chemical Industry of the USSR. An experimental department for its production has been put in operation at an unnamed Soviet chemical plant, and several more plants are planning to follow suit in the near future.

The production process is based on the continuous counter-flow method for photo-chemical chlorination of benzol. Process of continuous photochemical chlorination of benzol is achieved in a column-type apparatus, with quartz-mercury lamps mounted inside the reactor. A continuous process has been developed for the chlorinator, with a daily capacity of 110 lb. of hexachlorane, which equals over 1,650 lb. of 7 percent dust hexachlorane preparation.

Australia Makes Progress In Producing Plastics

A GROWING variety of Australian-made molding materials is displacing imported products from the Commonwealth market, a survey by the Plastics Institute of Australia reveals. I.C.'s, Beetle Elliott's, Monsanto's and Reichhold's Australian Branch plants are competing with four Australian concerns in standard phenol-formaldehyde powders and resins, and the same setup, minus Monsanto, is pushing urea formaldehydes.

Beetle Elliott and Selinite Ltd. have recently taken up production of phenol furfural, and Beetle and Hardie Trading Company are offering Australian-made melamine formaldehyde resins.

I.C.I.'s branch plants are turning out cellulose acetate, vinyl acetate, vinyl acetals, vinyl chloride and polyacrylic and methacrylic esters. Two firms, Benco Pty. Ltd. and Cast Resin Pty. Ltd. specialize in casein resins, and Timbrol Ltd. is producing cumarone indene.

Self-sufficiency in starting materials is still a long way off. Only Monsanto and Timbrol Ltd. make their own phenol, while I.C.I. shares with Monsanto a monopoly on formaldehyde. I.C.I. is the only producer of urea. All solvents are imported. No Australian firm is yet producing vinyl chloride acetate, polyesterenes, allyl resins, unsaturated polyesters, synthetic rubbers, silicon resins, extenders, polyethene, polyethelene or nylon.

Penicillin Plant Begins Operation in Sweden

Located in Stockholm, the first penicillin plant in Sweden is now in operation and is marketing the product in commercial quantities. The plant was designed by Technical Enterprises, Inc., New York, and was built to produce a maximum of 50 billion units of penicillin a month. It is expected that this goal will be reached early this summer and the plant has been so constructed that additional capacity may be added if desired.

South Africa May Produce Chrome Chemicals

With the exhaustion of higher grade chrome ore in many countries, the lower grade ores of the Transval may be used to produce ferro-chrome and chrome chemicals for export. In 1938, reserves of chrome ore in South Africa were estimated at 200,000,000 tons. The ore has a chromic acid content of less than 40 percent. In the northern Transvaal, where the major deposits are, ore has been traced for about 170 miles. The shallowness of deposits makes cheap mining possible but principal limitations are transport costs, low average grade of ore, and lack of machinery and equipment. Lourence Marques in Mocambique is the nearest shipping port.

Russian Research on New Medical Preparations

To coordinate the activity of Soviet scientific research institutions engaged in production and synthesis of new medical preparations such as penicillin, streptomicine and sulphamides, as well as to promote introduction in medicinal practice of new chemical and biological medicaments,

a special chemical-therapeutical committee has been set up with the Scientific Medical Council of the Ministry for Public Health of the USSR. Two commissions are being set up with the new committee: for antibiotics, under Prof. Z. V. Yermolieva, and for chemical preparations, under the guidance of Prof. Sh. D. Moshkovski.

Bulgaria Will Have New Plants for Chemicals

ESTABLISHMENT of chemical plants in Bulgaria with the help of the Soviet Union is being studied by Traitcho Kostov, vice-president of the Council of Ministers, interested members of the Cabinet, and members of a Soviet Study Commission. It has been decided to accelerate construction of plants for production of chemical fertilizers, sulphuric acid, copper sulphate and phosphate.

Foreign News Briefs

Crystal urea production has been started in Poland according to an announcement from the Central Board of the Chemical Industry. Current production is required for home use but it is hoped that later the output may be extended so as to have a surplus for export.

Tire production in Brazil has doubled since 1939. The Brazilian Government Trade Bureau reports that the current annual rate ranges from 700,000 to 800,000 units.

Two viscose rayon plants are in operation in Austria. One in Upper Austria in the American zone of occupation produces staple fiber and the other in Lower Austria in the Russian zone produces filament yarn.

Argentina exported 48,840 metric tons of quebracho extract in the first three month of this year compared with 68,240 metric tons in the corresponding period of last year.

Hungary will attempt to increase its output of chemicals by 42 percent over what it was in 1938. This is in accordance with a three-year plant to start in August 1947 and continue up to August 1950.

China was faced with a shortage of sulphur for its paper, chemical, and fertilizer industries so the National Resources Commission has begun the mining of pyrites at Ma An Shan, Kiangsu Province. Daily production has been running about 120 tons of ore with a sulphur content just above 40 percent. It is planned to increase the daily ore output to 300 tons.

THE CORROSION FORUM

MODERN MATERIALS • MODERN METALS

of Chemical & Metallurgical Engineering

Edmond C. Feller, ASSISTANT EDITOR

Sulphur Dioxide vs. Materials of Chemical Plant Construction

Part 1 of a symposium in which manufacturers of typical materials evaluate their products for services involving wet and dry SO_2 and sulphurous acid

WORTHITE

W. E. PRATT

Worthington Pump and Machinery Corp.
Harrison, N. J.

WET sulphur dioxide gas and sulphurous acid conditions are nearly identical in their corrosive effect on chrome-nickel-moly and nickel-chrome-moly alloys. Theoretically, the wet SO_2 gas should be less corrosive to these types of alloys due to the probability of the environment having more oxidizing capacity. The opposite would be true when bronzes or nickel-copper alloys are involved.

Stainless alloys of the 18-8SMo type (CF7M or Types 316 or 317) have been considered for some time as acceptable alloys for SO_2 and H_2SO_3 conditions in the sulphite pulp and paper industry. The higher alloyed nickel-chrome-moly alloys such as Worthite have proved more useful when some sulphuric acid is present. If a film of sulphurous acid is left on a surface under shut-down conditions it is possible, with air present, for some oxidation to take place and form H_2SO_4. At the high temperatures encountered in SO_2 cooler pipes or water spray pipes used for cooling the SO_2 gas from 1,100 deg. F. to approximately 400 deg. F., Worthite has proved to be superior to the regular chrome-nickel-moly stainless steels.

Worthite pumps have been widely used for pumping sulphurous acid where there is no question but what 18-8-moly alloys would have given excellent service. Worthite pumps, being a standardized alloy for Worthington chemical pumps, are available quicker at a lower price and repair parts are always available. This situation does not apply to castings, pipe, fittings and valves and hence Worthite in these forms is used only where very high temperatures or where the presence of sulphuric acid makes the Worthite more economical at the higher cost.

Worthite sulphurous acid tower circulating pumps have given exceptional performance records for a long period of years requiring no repairs. Installed with independent water seals on the stuffing boxes, the pumps require repacking only at general overhauling periods or otherwise not more frequently than about once a year.

Laboratory tests on hot sulphurous acid have shown no loss. Worthite pumps in service since 1936 handling 1.05 sp. gr. H_2SO_3 show no signs of corrosion. Worthite pumps used for seven years circulating sulphite acid at 250 deg. F. in pulp digestion show no signs of corrosion despite the long period of use.

A test on Worthite in a 10 percent solution of sodium bisulphite containing 2 percent SO_2 at 176 deg. F. showed no loss. Scrubber gas effluent contains appreciable percentages of SO_2 or H_2SO_3. A test was made by a large public utility company on Worthite in this effluent for a period of 20 months. The loss of weight was reported as only 0.75 percent, or practically nothing. Where smelter gas is used for the manufacture of sulphuric acid (instead of burning sulphur or pyrites) that gas is usually passed through scrubbers to remove flue dust. The scrubbers are usually of lead construction and Worthite pumps have been used successfully in circulating water over the scrubber. The pump therefore has to handle a hot, weak sulphurous acid solution containing appreciable percentages of solids. Subsequently the SO_2 gas is dried by passing through a tower over which a Worthite pump circulates concentrated sulphuric acid which becomes saturated with the SO_3. No discernible corrosion or wear has been reported on such application of Worthite pumps.

In the handling of other corrosive solutions containing some SO_2 the rates of corrosion are generally in the order of what might be expected by the corrosive elements present other than SO_2. Such solutions are encountered in many processes involving the manufacture of adhesives (H_2SO_4 and H_2SO_3), some types of plating solutions, starch manufacturing, and fatty acids (Tall oil) involving small amounts of sulphuric and sulphurous acids at 300 deg. F. Worthite is giving excellent service in all of these fields.

There is some indication that Worthite and similar alloys should be applied with caution in very hot mixtures of sulphuric and sulphurous acids, where the oxidizing capacity of such solutions is reduced to nearly zero—especially in connection with systems involving large surfaces of lead. It is believed that this environment can cause "activation" of the alloy concurrently with "passivation" or ennobling of the lead surfaces by creating a heavy coating of lead sulphate. In a closed system it is possible that eventually the lead may become cathodic to the alloy and with very large areas of cathodic lead being connected to an alloy pump or valve of small area, the anodic current density on the alloy part could cause severe galvanic corrosion (see *Transactions*, Electrochemical Society, Vol. 86, 1944, "Effects of Oxygen Exhaustion from Corrosive Solutions on High Nickel-Chromium-Molybdenum Alloy Steels," reprints of which are available from the author).

One of the large sulphite pulp mills tested Worthite in a mixture of 5 percent H_2SO_4 and 0.5 percent H_2SO_3 at 176 deg. F. No loss resulted. Subsequently this mill installed a Worthite pump for circulating 5 percent H_2SO_4 at 180 deg. F. over a scrubbing tower

to remove SO_3 gas from the SO_2 gas. It was found that the H_2SO_4 built up to 5 percent concentration. The scrubber and the connecting lines were lead and of course galvanically connected to the Worthite pump. After six months the rate of corrosion on the Worthite proved excessive. The surfaces were blackened and showed the characteristic appearance of galvanic corrosion. If the investigation now under way indicates this to be the main factor in the corrosion, simple insulation of a Worthite pump from the lead would permit its use. No such insulation of Worthite in somewhat similar environments (as mentioned above) has been necessary, but other installations may have allowed some oxidizing capacity of the circulated solution.

If any users of nickel-chrome alloys in H_2SO_4-H_2SO_3 solutions are experiencing unexplained corrosion of a piece of equipment in a lead system, it would be well to investigate the oxidizing capacity of the acid, and to try insulating the alloy equipment from metallic contact with the lead.

NICKEL, NICKEL ALLOYS

W. Z. FRIEND
International Nickel Co.
New York, N. Y.

NICKEL and Monel are resistant to dry sulphur dioxide at temperatures up to about 600 deg. F. Above this temperature these materials are subject to intergranular sulphur attack which results in embrittlement. Inconel is resistant up to about 1,500 deg. F. The upper temperature limit for Ni-Resist has not been established. These limits apply also to wet sulphur dioxide gas where temperatures are always well above the dew point of the sulphur dioxide-water vapor mixture. Monel is used for valve and pump parts and miscellaneous fittings in handling anhydrous sulphur dioxide in the refrigeration and other industries. Type 1 Ni-Resist (an austenitic cast nickel-iron alloy, 14 percent Ni, 6 Cu) has been used for gas manifolds and distributors carrying hot mixed gases from sulphur burners to coolers in sulphite pulp mills.

None of these materials is resistant to wet sulphur dioxide at temperatures below the dew point of the sulphur dioxide-water mixture, nor in continuous exposure to sulphurous acid solutions containing more than about 0.3 percent SO_2 by weight. The results of a number of laboratory corrosion tests in sulphurous acid solutions are given in Table I. There are numerous applications, such as in the handling of fruit juices and food products containing sulphur dioxide as preservative, and in the handling of such solutions as steep water and gluten water in corn products plants, where SO_2 contents are low enough that Monel, nickel, and Inconel have good corrosion resistance. In some cases Monel and nickel may

Table I—Laboratory Corrosion Tests In Sulphurous Acid Solutions

Wt. % SO_2; Deg. F.	Corrosion Rate, Mils per year: Monel	Nickel	Inconel
0.15%, room	0.4	3.7	....
0.30%, hot	.....	120	....
1.0%, 68 deg.	62	54	11
1.5%, room	100	.....	....
4.1%, 122 deg.	.....	.....	67
5.0%, room	130	.....	24
5.0%, 86 deg.	.....	560	....
Water sat. with SO_2, room	880	.....	....
Water sat. with SO_2, 122 deg.	.....	.....	32
SO_2 gas sat. with water vapor, room	870	5,700	0*

* 80 percent Ni, 20 Cr alloy.

Table II—Corrosion Tests in Food Products Containing Sulphur Dioxide

Test 1: Lab. test in storage of natural red grape juice containing 1,500 ppm. SO_2; room temp.; 100 hr. duration.
Test 2: Lab. test in 0.34 percent tartaric acid containing 1,500 ppm. SO_2; room temp.; 100 hr. duration.
Test 3: Plant test in white grape wine fermenter with 100 ppm. SO_2 added as potassium metabisulphite; 64-88 deg. F.; 56 hr. duration.
Test 4: Lab. test in ginger ale sirup containing 320 ppm. SO_2; room temp.; 7 days duration.
Test 5: Plant test in storage of pectin liquor containing 0.20 percent malic acid and 0.05 SO_2; liquor changed each day; pH 3.0; 70-90 deg. F.; 26 days duration.
Test 6: Plant tests in storage of 2 percent apple pectin extract sat. with SO_2 at boil. pt.; tests in liquid and vapor; 70-90 deg. F.; 39 days duration.

	Corrosion Rate, Mils per Year: Monel	Nickel	Inconel
Test 1	0.9	5.4	....
Test 2	0.6	6.2	....
Test 3	0.1	0.5	<0.1
Test 4	0.4	0.6	0.2
Test 5	<0.1	3.9	<0.1
Test 6, liquid	3.2	16	<0.1
vapor	2.5	26	1.2

< = less than.

Table III—Plant Corrosion Tests In Corn Steep Water

Test 1: In evaporation of corn steep water containing 0.05 percent SO_2 and 0.5-1.0 percent organic acids; pH 3.5-4.5; 150 deg. F.; 40 days duration.
Test 2: In evaporation of corn steep water containing 0.05 percent SO_2 and small amounts of organic acids; first effect of triple effect evaporator; 190-200 deg. F.; 33 days duration.
Test 3: In circulating tank in corn steep water containing 0.10-0.14 percent SO_2; 125-135 deg. F.; 107 days duration.
Test 4: In corn steep water in germ separator; contains approx. 0.07 percent SO_2; room temp.; 184 days duration.
Test 5: In gluten settler in corn gluten water containing 0.05 percent SO_2; pH 3.6; 70-90 deg. F.; 77 days duration.

	Corrosion Rate, Mils per Year: Monel	Nickel	Inconel	Ni-Resist Type 1
Test 1, liquid	3.2	4.2	<0.1	21
vapor	3.1	3.0	<0.1	11
Test 2, liquid	4.4	9.5	<0.1	43
vapor	4.5	8.4	<0.1	40
Test 3	3.5	10	<0.1	5
Test 4	0.5	3.5	<0.1	5
Test 5	0.6	3.3	<0.1	5

< = less than.

show a superficial tarnishing due to SO_2 content and Inconel is superior in this respect. In Table II are given the results of a number of corrosion tests in juices and food products containing a small amount of sulphur dioxide. Table III gives the results of a number of corrosion tests in steep and gluten waters in corn products plants. Typical applications include the use of Inconel and Monel for pectin evaporators and for steep water evaporators.

Monel, nickel, Inconel, and Ni-Resist are not resistant to the strong sulphite liquors encountered in the acid plants, digesters and blow pits of sulphite pulp mills. Ni-Resist has been used to some extent for blow pit pipes. All of these materials have given good performance in handling the washed pulp after discharge from the blow pit. Monel, in particular, is used for such equipment as rotary pulp screens, thickeners, and washers. Ni-Resist is used for pumps, valves, pipe and fittings handling washed pulp and white water.

SILICONES

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Dow Corning Corp.
Midland, Mich.

SILICONES in their various forms have been exposed to wet and dry sulphur dioxide at atmospheric pressures and to sulphurous acid at room temperature for two weeks to determine their stability to these reagents. In general, the resistance of various silicone products to both wet and dry sulphur dioxide is good. With the exception of the silicone resins and certain Silastic stocks, the resistance of silicones to sulphurous acid ranges from fair to poor. The results of these tests are reported in the accompanying tables.

The effect of sulphurous acid on silicone fluids has not been determined. The stability of five different types of silicone fluids to wet and dry sulphur dioxide is rated as good. The maximum change in viscosity is 7.8 percent and the minimum change is 0.5 percent after 14 days of exposure at room temperatures.

The values reported in Table I are also a measure of the resistance of the various silicone greases to wet and dry sulphur dioxide.

Three silicone resins were exposed to both wet and dry sulphur dioxide and to sulphurous acid and found to be relatively unaffected. Test samples show very little change in size or weight after 14 days of exposure and the original size and weight is essentially regained after 10 days of reconditioning.

In general the stability of Silastic stocks to wet and dry sulphur dioxide ranges from fair to good. The resistance of most stocks to sulphurous acid is generally poor, with the exception that Silastic 120 appeared to be somewhat improved.

Table I—Resistance of Silicone Fluids to Sulphur Dioxide (14 days at 77 deg. F.)

Type of Fluid	Reagent	Viscosity Increase, %	Evaluation*
DC 200	dry gas	1.4	good
	wet gas	2.9	good
DC 500	dry gas	2.1	good
	wet gas	2.6	good
DC 550	dry gas	0.5	good
	wet gas	1.8	good
DC 703	dry gas	−5.5	good
	wet gas	−7.7	good
C 710	dry gas	0.8	good
	wet gas	2.1	good

* Ratings are based on observation of the condition of test samples as well as measurable changes in viscosity.

Table II—Resistance of Silicone Resins to Wet and Dry SO_2 and to Sulphurous Acid (14 days at 77 deg. F.)

Type of Resin	Reagent	Increase in Weight, % After Exposure [1]	Increase in Weight, % After Reconditioning [2]	Evaluation [3]
DC 993	dry gas	0	−1.4	good
	wet gas	0	−0.4	good
	H_2SO_3	1.9	−0.5	good
DC 996	dry gas	0	−0.7	good
	wet gas	0	−0.8	good
	H_2SO_3	1.8	−1.3	good
DC 2103	dry gas	0	−0.5	good
	wet gas	0	−0.9	good
	H_2SO_3	2.3	−0.9	good

[1] None of the samples showed change in volume. [2] After reconditioning for ten days. None of the samples showed change in volume. [3] Ratings are based on measurable changes and physical appearance of samples.

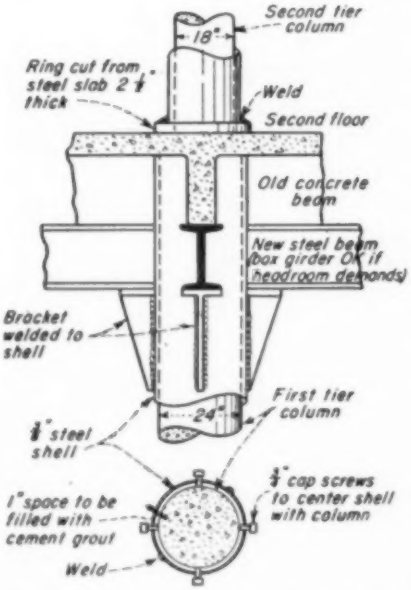
Table III—Resistance of Silastic to Wet and Dry SO_2 and to Sulphurous Acid (14 days at room temperature)

Silastic Stock	Reagent	Wt. Increase, %	Vol. Increase, %	Shore Efficiency Retained, % *	Evaluation †
120	dry gas	0	0	65	fair
	wet gas	0	0	81	fair
	H_2SO_3	3.9	0	84	good
125	dry gas	0	0	75	good
	wet gas	0	0	80	good
	H_2SO_3	7.8	0	69	good
150	dry gas	0	0	77	good
	wet gas	0	0	36	poor
	H_2SO_3	48	61	17	poor
160	dry gas	0.3	0	73	good
	wet gas	0	0	69	good
	H_2SO_3	17	15.7	35	poor
160 (Red)	dry gas	0.5	0	83	fair
	wet gas	0	0	62	good
	H_2SO_3	29	49	30	poor
167	dry gas	0	0	55	fair
	wet gas	0	0	57	fair
	H_2SO_3	9.6	0	34	poor
180	dry gas	0	0	48	fair
	wet gas	0	0	48	fair
	H_2SO_3	8.4	9.2	94	fair
181	dry gas	0	0	52	fair
	wet gas	0	0	52	fair
	H_2SO_3	8.9	0	97	fair

* Percent of Shore efficiency retained = (100) (hardness × elasticity of treated sample)/(hardness × elasticity of untreated sample). † Rating is based on changes in weight and volume, changes in durometer and elastometer readings, observation of the physical appearance of the test samples, and the effects of reconditioning test samples for 10 days.

FROM THE LOG OF EXPERIENCE

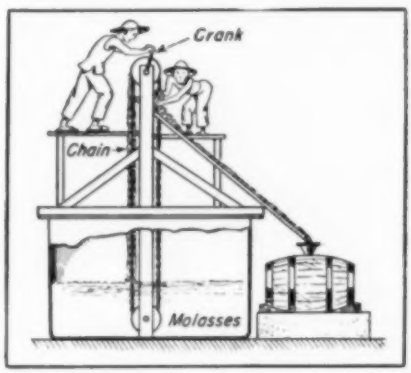
Dan Gulleben, ENGINEER



To bolster up a concrete floor beam

STRUCTURAL STEEL manipulation in an old plant requires arithmetic, imagination and a good welder. If the plant engineer happens to have inherited a reinforced concrete structure and his plant happens to be equipped with a "Doc" under whose research old equipment is made obsolete overnight and new and heavier loads are shifted around like checkers, then especially ingenuity is indispensible. One way of improving the load carrying capacity in the case of a reinforced concrete building is to scrap the building and replace it with a flexible steel design. On the other hand a happy solution of such a perplexity was achieved in the remodeling of the old Standard Oil Company warehouse in Long Island City to make it suitable for the new Pepsi-Cola sugar refinery. This building was substantially built by superior artificers in reinforced concrete and for an outfit that is not given to accepting base quality.

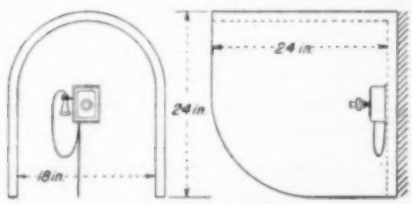
The foundations and columns possessed surplus carrying capacity but certain beams were not equal to the new concentrated loads. A reinforced concrete beam can be made stronger by encasing it in a steel box girder or by adding a steel beam under it, but to transmit the end reactions of this new addition to the columns is difficult because the concrete cannot be mutilated since there is no way of making new concrete monolithic with the old. The solution in the Pepsi-Cola refinery was to encase the reinforced concrete columns (which happened to be circular) with a ¼ in. steel shell, applied in two half cylinders and subsequently welded. To these cylinders the supporting brackets were welded. The job looks good, is effective, time-saving and reasonably cheap. See sketch.



At least it's ingenious

MOLASSES of stubborn disposition constituted one of the crosses that distressed the craftsmen in the Alvarado sugar house in the 1880's. The device which they evolved for transferring it from the storage tanks to the barrels consisted of an endless chain dragged slowly through the sticky mess and subsequently relieved of its adhering molasses by the squeegeeing of a pair of Chinaman's hands. The arrangement included foot and head sheaves mounted on a wood frame that was dropped into the tank after the manner of a marine leg used for discharging grain from ships. The head wheel revolved under benefit of a Chinaman applying force at the end of a crank. In 1888 the plant was reconstructed and Engineer H. P. Dyer mechanized the apparatus by replacing Chinaman No. 1 at the crank with a belt from a line shaft and No. 2, doing the squeegee act, with a piece of stiff rubber belt fastened to the bottom of the chute. This belt had a slot through which the chain was made to pass and thus squeegeed the molasses off the chain. For those who had the means, Guild and Garrison supplied a magma pump still widely used. This machine takes the shape of a horizontal plunger pump having a large funnel mounted on the top in the center of the cylinder. As the plunger passes the opening, gravity and partial vacuum force the heavy molasses into the cylinder. The return stroke, after passing the valveless opening on top, forces the trapped molasses out through a large spring-loaded check valve.

TELEPHONING in the machine shop or power house is a nerve-wracking experience, especially when an excited "polander" tries to spell out an emergency. Cabinets of acoustic material are everywhere providing comfort and utility at the expense of an awkward protruberation into the room. The efficacy of a telephone on a wall



Acoustical bonnet for plant telephones

or house column can be improved by fashioning over it out of acoustic board a "Quaker bonnet" as shown. It is big enough for an ordinary mechanic's head and almost as effective as the cabinet.

PHIL SWAIN AVERS that arithmetic is the old work horse that accomplishes more public service than any other division of engineering mathematics. It supplements an experienced imagination after the manner of Aaron upholding Moses' right arm. It can also impress the boss. In a midwestern sugar factory, the Master Mechanic was commissioned to install a cylindrical melting tank in the basement. The best spot for operating convenience centered with a column that carried three stories of heavy equipment. Operating convenience, which is a continuing circumstance, assumes

priority over the engineer's temporary discomfort, and so the column had to be removed. Accompanied by an impressive flourish and some arithmetic, but without consideration of possible alternatives, the obstructing column was cut out. A girder was installed under the ceiling to carry the load to two other columns which were reinforced and provided with additional foundation. This exhibition of structural skill impressed the Old Man. He didn't happen to know how that same problem was solved in a neighboring factory without costly mutilation of the structure. The melter there is equipped with a tangential stirring impeller and provided with an 18-in. well in the center like the well-known doughnut. Thus the hole, proverbially useless, performs the important service of providing space for the column. No exhibition of boldness and not even any arithmetic. Only some imagination and a welding machine.

Junipero Sera, the famous architect of the California Missions lacked mechanical equipment for molding roof tiles. His men, sitting comfortably on benches, formed slabs of stiff clay over their legs. The smaller end being near the knee telescoped under the larger end. The practical engineer must not lack versatility, as was the case with a famous German artist who sought to improve a barnyard scene by adding an egg under a rooster.

THE BETTERAVIA sugar factory in California was designed in 1897 by J. C. H. Stutt, famous as the builder of San Francisco's cable railway system. This factory started with a capacity of 500 tons of beets per day and by 1919 occasional additions had brought this to 1,250 tons. Stutt had employed so generous a factor of safety as to require little thought for the structure. One Saturday night the four pans and the crystallizers, tanks and mixers on the three upper floors were all simultaneously loaded to the limit. The last straw overcame the resistance and four columns suddenly sank 3½ in. The gateway for the relief of the load was the centrifugal station, and this could not operate because the drive shaft was out of line. Manager Truscott borrowed a truckload of hydraulic jacks from a neighborly oil operator and by Tuesday night he had the works on an even keel with new concrete piers under the four columns. The old brick piers, laid in lime-cement mortar had softened due to the effect of acid developed by years of surreptitious dribbling of sugar sirup from a leaky melter tank sunk into the ground. Let this be a lesson. Don't install submerged tanks without concrete pro-

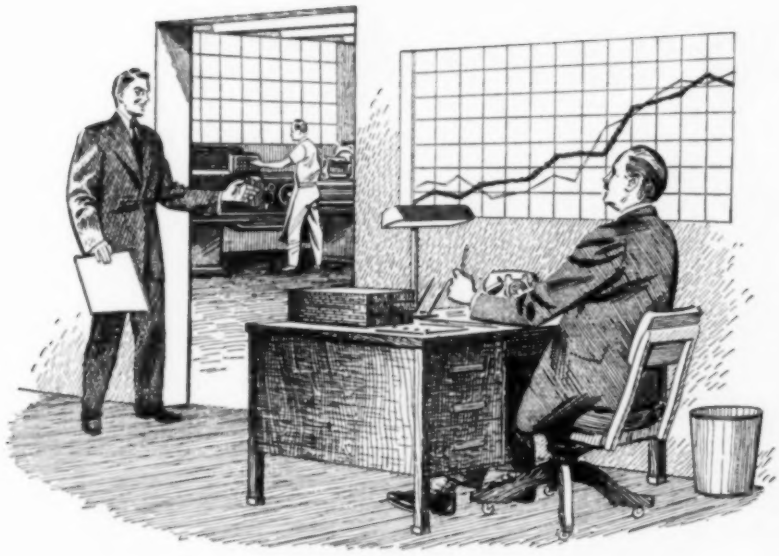
tection. The formula to "make it last as long as we're here" should be reinforced to add an extra generation.

ARITHMETIC averts disaster. That's why engineers are required to be licensed. A well-known sugar house operator, devoid of engineering instinct, coveted some of the easy money that the traffic promised at the end of War I. He contracted for the molasses output of Wrigley's Gunnison, Utah, factory. He had the idea of leasing the plant at the end of the manufacturing season and then processing the molasses through osmose filters which were cheaply available from discarded stock at the Madison, Wisconsin, factory. Table cloth doodling yielded the exciting fact that the 100,000-ton harvest of beets would produce 1,250,000 gal. of molasses, and each gallon could be counted on to yield at least 1½ lb., of sugar through the osmose process. An astute salesman could wangle 25c. a pound from hungry customers. Accordingly he impounded the molasses in an earthen reservoir formed by a dyke—a common practice. While he was counting his profits, the molasses level was approaching the top of the dyke. Suddenly the earth bank ruptured and the molasses escaped and dissipated itself over much of Sanpete County.

The log of the Sugar City, Colorado, factory about 40 years ago records an experiment with an open reservoir during a stormy night. All of the tumble weeds in the country gravitated to the sugar house and became entangled in the molasses.

EXPERTNESS in court testifying is established by orating into the records the experience rating of the witness and his more or less imposing list of scientific society affiliations. The successful practice of expert witnessing is supplemented in Doc's case (or any "Doc," generically) by a certain psychological attribute as exhibited in a recent experience. He was called to testify in behalf of a client whose plant was emitting offensive odors. There was no way of concealing the guilt. It stuck out like a sore thumb. The best the defendant could expect was to avoid the penalty that the enraged neighbors clamored for and to appease them by proving diligence in the installation of means for removing the cause. The prosecuting attorney elicited from Doc that the device for avoiding the neighborhood distress included a "scrubber." The attorney, in his technical knowledge, visualized a progressive deterioration of efficiency as the bristles fell from the brushes, especially by the effect of the lye that Doc proposed to use! Doc admitted

Has your plant hidden losses in maintenance costs?



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the propriety of the attorney's criticism and then proceeded to clarify his design to avoid the difficulty anticipated by the attorney.

According to standard legal technique, the attorney formulates an answer for the witness and concludes with, "Correct?" The inflection of course implies affirmation, and Doc did not disappoint or deflate him, but through courteous demeanor obtained permission to "clarify and interpret." By the time Doc's interpretation was finished the attorney was unwittingly and gracefully eased into the possession of the correct answer which was entirely at variance with the preformulated one. At the same time, the judge had the facts and everybody was impressed with Doc's technological erudition. The plaintiffs were satisfied and decided that after all Doc was entitled to a reasonable extension of time without penalty to solve a stubborn problem.

LARGE PRIVATE COLLECTIONS of books on specialized subjects eventually gravitate to some permanent public library. On the other hand the little collections of a half dozen volumes or more that once served the bread-and-butter purpose of some retired or long buried craftsman, eventually lose their sentimental attachment and fetch up in the garbage can. These books, issued in small editions, long since out of print, are highly prized by college libraries. A recent search of the chronicler's among old timers and heirs, supplemented by a tour of second hand book shops, returned a harvest of historical value. Among these are four volumes exceeding 100 years in age, of which there are probably not more than a half dozen volumes extant. These are now safely stored in college libraries available for the study of the roots of sugar craftsmanship. For a small investment in money and effort an important item can now be added to the list of retirement activities recommended by Marcus Cato, Ph.D., exactly 2,000 years ago. At the top of his list there was the unselfish activity of planting trees from which the old man could not expect to derive any profit.

FINLEY SPRATT, who had grown up with the old boilers and developed into an operator on the new ones, still feels uncomfortable under the superior discipline of alertness demanded by the new order. During a period of relaxation he was leaning against the firing aisle railing overlooking the presently unused space once occupied by the easy-going boilers, and he was heard to muse with nostalgic feeling, "Them were the good old boilers."

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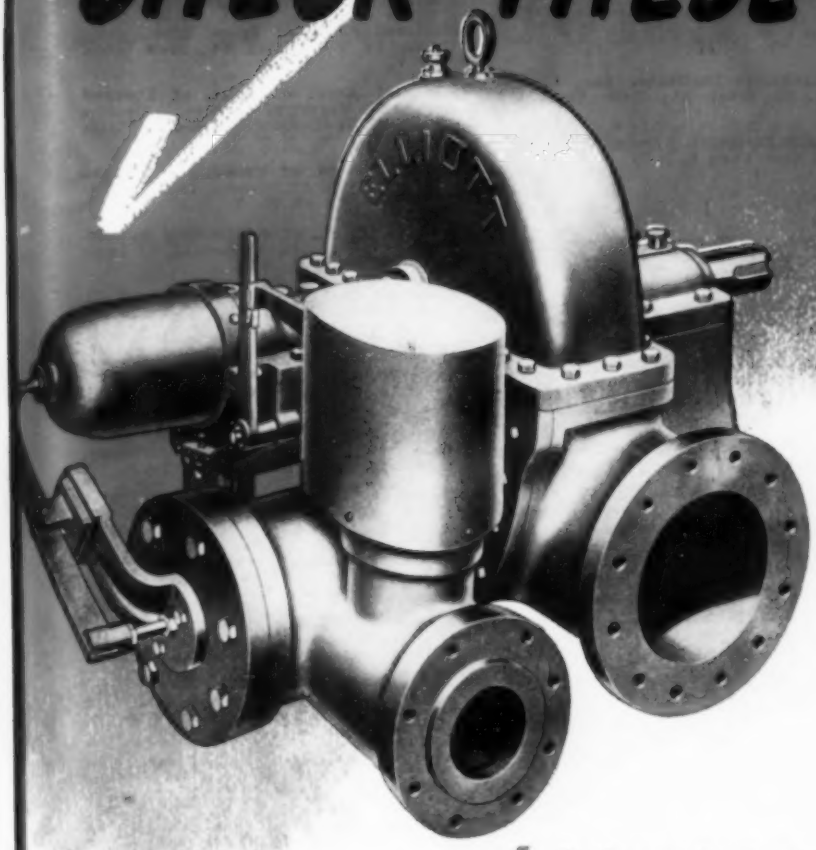

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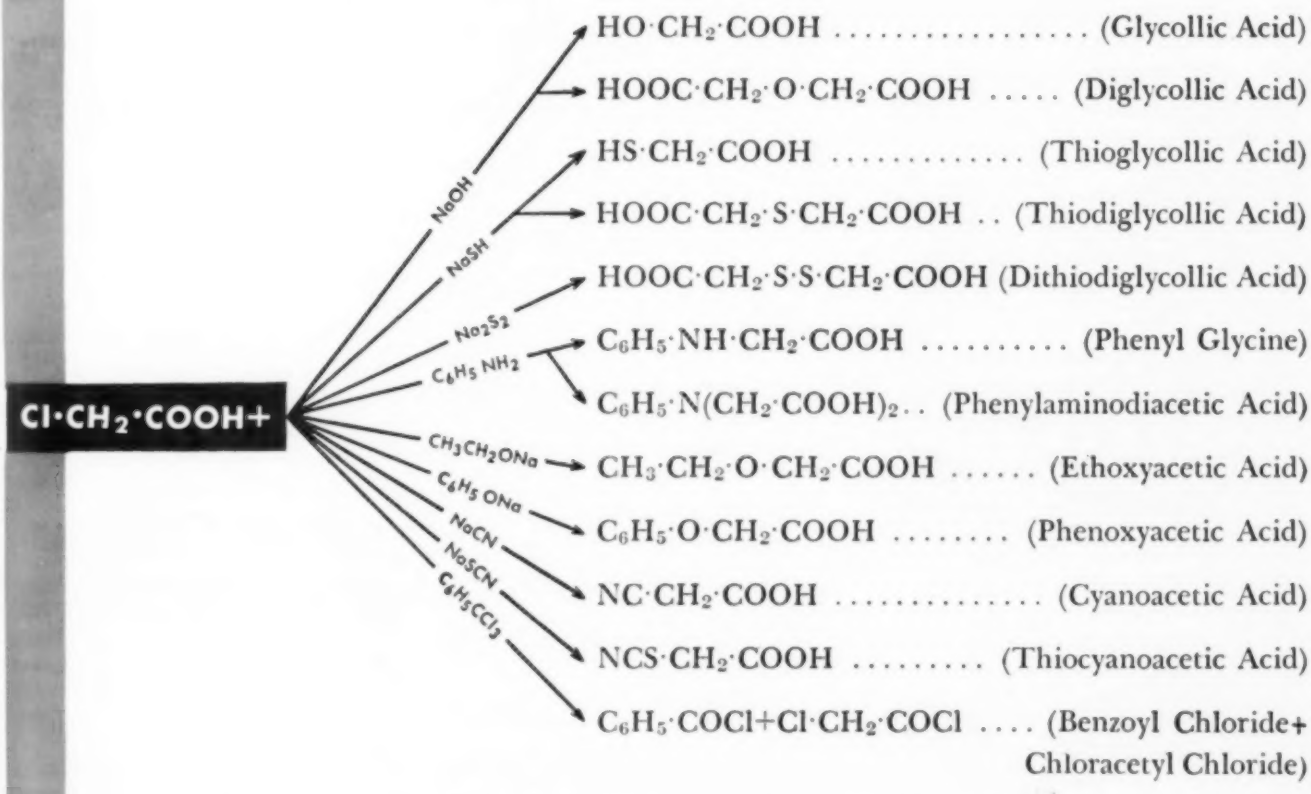

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Synthetic Organic Chem. Mfrs.' Assn. of the United States. Pres., Ralph E. Dorland, Room 1002, 6 East 45th St., New York 17, N. Y.

T

Tanners' Council of America. Sec., J. L. Nelson, 100 Gold St., New York 7, N. Y.

Technical Assn. of the Pulp & Paper Industry. Sec., R. G. Macdonald, 122 East 42nd St., New York 17, N. Y.

Textile Color Card Assn. of the United States, Inc. Sec.-Man. Dir., Margaret Hayden Rorke, 200 Madison Ave., New York 16, N. Y.

Tile Mfrs.' Assn., Inc. 50 East 42nd St., New York 17, N. Y.

U

Underwriters Laboratories. Pres., Alvah Small, 207 East Ohio St., Chicago 11, Ill.

U. S. Alkali Export Assn. Inc. Pres., E. V. Finch, 11 Broadway, New York 4, N. Y.

U. S. Brewers Foundations Inc. Sec., C. D. Williams, 21 East 40th St., New York 16, N. Y.

U. S. Pulp Producers Assn. Exec. Dir., O. M. Porter, 122 West 42nd St., New York 17, N. Y.

U. S. Shellac Importers Assn., Inc. Sec., George E. Ashby, 155 John St., New York 7, N. Y.

W

Washington Academy of Sciences. Sec., C. L. Gazin, U. S. National Museum, Washington 25, D. C.

Water Softener & Filter Institute. Vice Pres., C. Hungerford Jr., c/o Inversand Co., Clayton, N. J.

Wood Chemical Institute, Inc. Sec., M. H. Haertel 1426 G St., Washington, D. C.

NAMES IN THE NEWS

Kenneth H. Klipstein

Ray H. Boundy

Paul R. Croll

Kenneth H. Klipstein has been appointed an assistant general manager in charge of the development department of the Calco Chemical Division, American Cyanamid Co., Bound Brook, N. J., and **V. E. Atkins** has been appointed manager of manufacturing. It was also announced that **Ames B. Hettrick,** formerly an assistant manager of the pigment department, had been named assistant manager of manufacturing, and that **L. M. Phelps** will assume the post of plant production manager, Bound Brook plant, formerly held by Mr. Atkins. **F. W. Zipf** was named assistant to the manager of production. Mr. Klipstein prior to his new appointment was director of new products development. He is a graduate of Princeton University where he obtained his degree in 1921 in economics and an M.A. degree in chemistry in 1924. He joined the family firm of E. C. Klipstein & Sons, South Charleston, W. Va. which was later purchased by Calco.

Crawford H. Greenewalt has been appointed vice-chairman of the Executive Committee of the E. I. du Pont de Nemours & Co., of Wilmington, Del. Mr. Greenewalt is a vice president and director of the Company. He joined du Pont as a chemist in the Philadelphia Works in 1922 upon his graduation from M.I.T. He was elected director in 1942 and succeeded Jasper E. Crane as vice president and member of the Executive Committee in May, 1946.

Ray H. Boundy, manager of the Plastics Division of The Dow Chemical Co., returned on June 7 to the scene of his undergraduate days to receive an honorary doctor of science degree from Grove City College.

Howard L. Gerhart, staff chemist at the Milwaukee research laboratory of Pittsburgh Plate Glass Co. since 1937, has been appointed director of research for the paint division with headquarters at Milwaukee.

Henry W. Kayser has recently assumed new responsibilities at the Falk Corp., Milwaukee, Wis., with his appointment as supervisor of development engineering.

Charles Edward Kircher, Jr., of Wilmington, Del., has accepted an appointment as professor of chemical engineering at Rose Polytechnic Institute. For the past 14 years Dr. Kircher has been employed by the E. I. du Pont de Nemours & Co. on research and development problems, with the exceptions of leaves, granted for graduate study and special government service. He is a native of El Paso, Tex.

Maurice Brooks of Cooper Union has won the Henri D. Dickinson prize of $125, awarded to the evening course student with the best record.

Chester L. Knowles has announced Knowles Associates, a concern of consulting engineers with offices in New York, N. Y. He is associated with Otto R. Kuster and Robert C. Reid.

Paul R. Croll has been named assistant to the vice president in charge of the paint division, Pittsburgh Plate Glass Company. In addition, he will have overall responsibility for manufacturing operations of the various branches of the division. Associated with the company's paint division since 1922, Mr. Croll joined the firm as research director with headquarters at Milwaukee, Wis. In 1940 he was appointed technical assistant to the vice president and transferred to the company's general offices at Pittsburgh.

Irving Spiewak of New York has been awarded the Cooper Union's $1500 Emil Schweinburg award for graduate study in the field of engineering. The prize is to permit outstanding members of the graduating class of the Cooper Union School of Engineering to continue their studies at the graduate school of their choice. Mr. Spiewak, a chemical engineering graduate, has elected to attend M.I.T.

Richard J. Cody, formerly sales manager of the Container Corp. of America's carton plant at Boston, Mass., has recently joined the staff of Container Laboratories, Inc. A graduate chemical engineer from the University of Wisconsin, Mr. Cody entered the industry in 1928.

Robert Robinson has been awarded the Albert Medal by the Royal Society of Arts for his outstanding contribution to the advancement of organic chemistry. Sir Robert, who is Waynflete Professor of Chemistry at Oxford and

president of the Royal Society, is a member of the committee appointed last month by the Minister of Education to consult with him on all matters affecting U.N.E.S.C.O.

E. M. Stiles, chief engineer, Consolidated Mining & Smelting Co. of Canada, Ltd., Trail, B. C., and **R. R. McNaughton**, manager of the metallurgical department of the company, have arrived back after almost three months engaged in an aerial tour of Australia. The officials made an extensive study of mines and other industrial operations in the Antipodes.

William H. Lycan, formerly director of paint division research with headquarters at Milwaukee, has been appointed executive director of research, Pittsburgh Plate Glass Co., with offices at Pittsburgh. He will have jurisdiction over all paint division research, new product development, promotion and marketing.

M. Martin Maglio, formerly director of the Jersey City Laboratories and pilot plant operations of Advance Solvents and Chemical Corp., and also assistant professor of chemistry at St. John's University, has been appointed chemical director of Vestal Laboratories, Inc., St. Louis, Mo.

Frank Reese has been appointed by Monsanto to lead the research mechanical development group of plastics research. Mr. Reese received his B. S. degree in chemical engineering from Purdue University in 1941.

Albert Hermon Case, vice president and consulting engineer of Tennessee Corp. was awarded a Medal for Excellence by Columbia University on June 3. This medal is presented annually to an alumnus for public service.

Wilbur A. Lazier, director of the Southern Research Institute, Birmingham, has been elected chairman of the Alabama Section of the American Chemical Society.

Howard L. Ginaven has been appointed general superintendent of Goodyear Tire & Rubber Co.'s plant at Wolverhampton, England.

John H. Long has been appointed assistant general manager of the Paper Makers Chemical Department of Hercules Powder Co.

Julian S. Gravely has been compelled by ill health to retire from the active management of the Beryllium Corp., Reading, Pa. At a meeting of the Board of Directors the by-laws of the corp. were amended so that the Chairman of the Board would have no participation in the management of the corporation, other than as a director. Thereupon, Mr. Gravely resigned from all offices and was re-elected Chairman of the Board.

James H. Boyd has resigned from the Phillips Petroleum Co. with which he has been connected some years and has established consulting practice, with offices at 250 Park Ave., New York.

George J. Easter is now connected with Electro Refractories & Alloys Corp., Buffalo, N. Y. in the capacity of Director of Research. Mr. Easter has been with the Carborundum Co. in the capacity of Manager of Research and Development and the acquisition of his services by Electro is in line with the policy of this corp. to put increased emphasis on research.

Fred Olsen

Fred Olsen, chief of research and technical development of the Western Cartridge Co. division of Olin Industries, East Alton, Ill., has been elected a member of the Board of Directors of Olin Industries.

Alex F. Robertson has joined the staff of the Institute of Textile Technology, Charlottesville, Va.

Robert P. Beaven has been appointed to the technical service staff of the Rumford Chemical Works, Rumford, R. I.

Arthur L. Gardner, production manager of Monsanto Chemical Co.'s Merrimac Division, has been appointed assistant to the division general manager.

James M. Barker has been elected to the board of directors of Universal Oil Products Co., Chicago.

Harold Clifford Graves has joined the staff of **Chemical Engineering** and will will be in charge of market research

work. He was formerly with the Shell Oil Co.'s advertising department. Mr. Graves is a chemical engineering graduate of M.I.T.

Gustav Egloff of Universal Oil Products Corp., has been nominated for president of the Chicago Technical Societies Council.

Paul Van Cleef, vice president, Van Cleef Bros., Inc., has been appointed to the Chicago Board of Education.

Howard S. Gardner, associate professor and chairman of the Chemical Engineering Department, University of Rochester, resigned July 1 to enter the industrial field as director of research and development of Fibreboard Products, Inc., San Francisco, Calif. Dr. Gardner will head the firm's new research and development division to be established in Antioch, Calif. He has been a member of the University of Rochester faculty since 1938 when he was appointed director of the chemical engineering laboratory. Early this year he was promoted to the chairmanship of the Chemical Engineering Department, Division of Engineering.

Ze'ev Halperin, chemical engineer, has returned from Palestine and Europe where he served as a consultant on wine and winery wastes. He resumes his practice at 1663 Longwood Ave., Los Angeles.

Ralph W. Peakes, for 24 years a chemist with the Chemical Corps, retired April 20 at the Army Chemical Center, Maryland. Mr. Peakes was educated at Massachusetts State College and Harvard Graduate School. He was employed by private industry from 1908 to 1921 and joined the Chemical Corps the following year.

OBITUARIES

William H. Ross, 71, retired principal chemist of the division of soils, fertilizers, and irrigation, Bureau of Plant Industry, U. S. Department of Agriculture, died in Washington, D. C., May 16.

G. L. Kothny, 66, vice president and general sales manager of the Sperry-Sun Well Surveying Co., died in Philadelphia May 28.

Louis W. Kempf, age 49, assistant director of research at the aluminum research laboratories of the Aluminum Co. of America, died at the home of a friend in Cleveland on June 14.

Edward L. Stine, 86, a Ferro Enamel Corp. executive until his retirement three years ago, died at his home in Cleveland May 19.

Herbert H. Meyers, 56, vice president of the Virginia-Carolina Chemical Corp., died after a short illness in Richmond, Va., May 12.

Clark S. Robinson, Dept. of Chemical Engineering, Mass. Inst. of Technology, and author of "Elements of Fractional Distillation," died in Cambridge May 24.

George E. Price, Jr., age 57 years, purchasing agent for Goodyear Tire & Rubber Co., and associated with the Co. for 25 years, died May 30 in an Akron hospital after a short illness.

Christopher Offenhauser, president of Mixers, Inc., Philadelphia, died at his home on May 22.

R. R. Ridgway

Raymond R. Ridgway, research director of the Norton Co., Chippewa, Ont., died June 12. Dr. Ridgway was 49 years old. Death was due to drowning in a boat accident on the upper Niagara River.

Louis W. Bosart, 75, retired soap chemist of the Procter & Gamble Co., died in Dayton, June 21.

Grinnell Jones, 63, chemistry professor at Harvard, died in Cambridge June 23. He taught at Illinois before joining the Harvard faculty in 1912. From 1917 to 1919, he was chief chemist for the U. S. Tariff Commission and consulting chemist to the commission until 1926.

Frank C. Whitmore, 59, dean of the School of Chemistry and Physics at Pennsylvania State College, died at his home in State College June 24. In 1938 he was president of the American Chemical Society and received the William H. Nichols Medal in 1937 and the Willard Gibbs Medal in 1945.

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Simple to remove . . . and *simple to service!* Taken apart and cleaned in a jiffy, reassembly is no trouble at all: there are *no* adjustments to be made.

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THE ONLY TOTALLY-ENCLOSED CONTROL-UNIT

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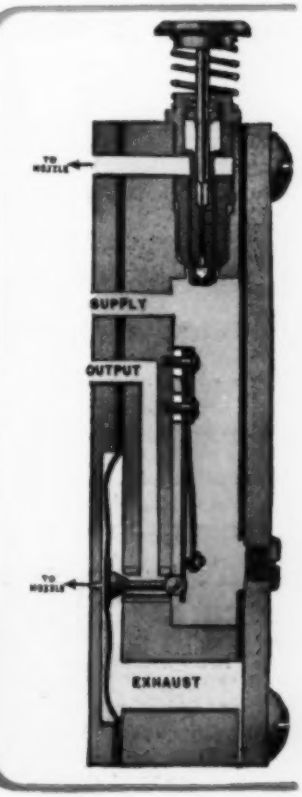

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INDUSTRIAL NOTES

Illinois Testing Laboratories, Inc., Chicago, has appointed J. A. Ariano, 136 Liberty Street, New York, representative.

Clarostat Mfg. Co., Inc., Brooklyn, N. Y., has named C. W. Henderson sales engineer in the Philadelphia area.

Reheis Co., Inc., Newark, N. J., is the new name for Schofield-Donald Co., Inc. Daniel H. Reheis is president.

Sharp & Dohme, Inc., Philadelphia, has moved the Denver office to new quarters at 1525 Wynkoop St.

West Virginia Pulp and Paper Co., New York, has elected William L. Merrilees assistant secretary.

Columbus Plastic Products, Inc., Columbus, has moved to the new plant at 1625 W. Mound St.

Owens Illinois Glass Co., Toledo, has appointed Edwin J. Rhein sales manager of the scientific division; E. B. Dennis, Jr., sales manager of the container and accessories division and Edward W. Charlesworth sales manager of the tube and rod division for Kimble Glass.

Ajax Flexible Coupling Co., Inc., Westfield, N. Y., has appointed Robert G. Cady manager of the materials Handling Division.

B. F. Goodrich Co., Akron, Ohio, has appointed Warren H. Hackett and E. A. Doerschuk assistant treasurers. H. V. Gaertner former assistant treasurer has become controller.

Polymer Industries Inc., Astoria, N. Y., has announced that Moses Konigsberg and Howard L. Kane are now associated with Frank C. Campins and John W. Ogletree as directors and officers of the company.

Babcock & Wilcox Co., New York, has appointed Portilla Corp. as Puerto Rican Agent to succeed H. Glyde Gregory, Inc.

Reliance Electric & Engineering Co., Cleveland, has named A. R. Hough southern sales representative with headquarters in Knoxville, Tenn. He succeeds A. L. Pollard who retired.

Celanese Corp. of America, New York, appointed Emery N. Cleaves assistant to the president.

American Car and Foundry Co., New York, has appointed T. C. Ballou manager of welded products sales.

Reading Chain and Block Corp., Reading, Pa., announce the following new district representatives: H & H Foundry Supply, Detroit; Ellis Scott Co., Indianapolis, Ind.; Hall Equipment & Engineering Co., Cincinnati, Ohio, and the Russel C. Hedeen Co., San Francisco, Calif.

H. W. North Co., Erie, Pa., has appointed Bullock-Smith Associates as engineering representatives and eastern sales agents for North-Erie process equipment. H. L. Bullock is technical director with headquarters at 136 Liberty St., New York.

Air Reduction Sales Co., New York, has appointed H. C. Wallace manager of the Louisville district.

American Car and Foundry Co., New York, has elected Charles J. Hardy, Jr., president to succeed F. A. Stevenson who resigned.

J. A. Zurn Mfg. Co., Erie, Pa., has appointed Albert A. Sterling, Jr. district engineer with headquarters in Houston, Texas.

International Nickel Co., Inc., New York, has placed Hugh J. Fraser, vice president, in general charge of plant operations in the United States. John A. Marsh has been named his assistant.

Tennssee Products & Chemical Corp., Nashville, is the new name for Tennessee Products Corp.

Sola Electric Co., Chicago, has moved all its plants to the new building at 4633 West 16th Street.

Link-Belt Co., Chicago, has reestablished a sales office at 1009 Washington Gas Light Bldg. at 11th & H Sts., N.W., Washington, D. C. with C. R. Heller in charge.

D. J. Murray Mfg. Co., Wausau, Wis. has moved its Chicago office to Room 648 First National Bank Bldg., 38 South Dearborn Street. O. J. Malina is in charge.

Arco Co., Cleveland, has announced that Howard E. Wise, president, has

been elected to the Board of Trustees of Western Reserve University.

Air Reduction Sales Co., New York, has opened two new oxygen plants. George H. Elingenberg is superintendent of the new Decatur, Ill. plant and J. L. West is plant superintendent in Baton Rouge, Louisiana.

Monsanto Chemical Co., St. Louis, has elected Dr. Charles A. Thomas executive vice president and Felix N. Williams to the board of directors. Additional vice presidents elected were: Josiah B. Rutter, Dr. C. A. Hochwalt, William W. Schneider, Daniel M. Sheehan, and C. A. Wolfe.

Commercial Solvents Corp., New York, has appointed John H. Schriever pharmaceutical director. His headquarters will be in the New York office.

Minneapolis-Honeywell Regulator Co., Minneapolis, has elected James H. Binger assistant vice president.

Industrol Corp., Long Island City, N. Y., is the new name for Industrial Instrument Service Co.

Pennsylvania Pump and Compressor Co., Easton, Pa., has named Ellis R. Snovel, president to succeed Ward Raymond who has resigned.

Hammel-Dahl Co., Providence, has appointed Frank J. and Arthur T. Carr as New England sales representatives operating from Boston, Mass., as the Carr Bros. Co.

Allis-Chalmers Mfg. Co., Milwaukee, has appointed William A. Roberts and William C. Johnson executive vice presidents, respectively, of the tractor and general machinery divisions. Two new vice presidents are Marshal L. Noel and J. L. Singleton.

Monsanto Chemical Co., St. Louis, has appointed Howard J. Hefferman, general sales manager of the Merrimac division at Boston. He succeeds Dr. Lester A. Pratt, who became assistant to the division general manager.

Colorado Fuel & Iron Corp., New York, has appointed W. T. Stratton director of purchases of the Wickwire Spencer Steel Division of the company and will be located at the Curtiss Building, 361 Delaware Ave., Buffalo, N. Y.

American Chain & Cable Co., Inc., Bridgeport, Conn., has appointed J. A. Bynum special representative on Read-

ing-Pratt & Cady valves for the petroleum industry in the southwest. J. J. Reed succeeds him as district sales manager for the Reading-Pratt & Cady division in that territory. Their headquarters are in Houston.

Independent Pneumatic Tool Co., Chicago, Ill., has opened a technical office at Sao Paulo, Brazil. Reuben P. Rudy is manager.

Ceco Steel Products Corp., Chicago, Ill., has appointed Bernard H. Lord manager of the New Orleans office, Walter E. Lord manager of the Milwaukee office, W. C. Richards assistant manager at Chicago and Lester R. Wise manager of the Chicago office.

Buchen Co., Chicago, Ill., has appointed Morris Mallory manager of the New Orleans office and J. A. Cragwall manager of the Kansas City division.

Kennametal Inc., Latrobe, Pa., has appointed Lawrence W. Guild manager of the New England district with headquarters at 1537 Main Street, Springfield, Mass.

American Car and Foundry Co., New York, has appointed Justus W. Lehr district manager in charge of the Berwick, Pa., plant.

H. K. Ferguson Co., New York, has announced the appointment of Dr. Gwch-Liang Lee as its representative in China with headquarters at Hankow.

United States Steel Corp., Chicago, Ill., has appointed John C. Cushing director of industrial relations of the United States Steel Supply Co.

Philco Corp., Philadelphia, has named Charles H. Godschall works manager of the Philco refrigerator-freezer production facilities.

Arma Corp., Brooklyn, N. Y., has elected Herbert C. Guterman president.

United States Steel Corp., Chicago, has appointed George B. Parker general staff manager of the sales department and William A. Crane manager of the commercial research division.

Dresser Industries, Inc., Cleveland, Ohio, has elected Rudolph E. Reimer vice president.

Wheelco Instruments Co., Chicago, has elected Elmer Schneider vice president and director of engineering. Joseph A. Reinhardt is plant manager.

HOW TO AVOID A LOT OF WORK!

10 YEARS—NOT A CENT FOR REPAIRS

Those traps on a milk drier delivered perfect performance for 10 years with their original parts.

20 YEARS' SERVICE

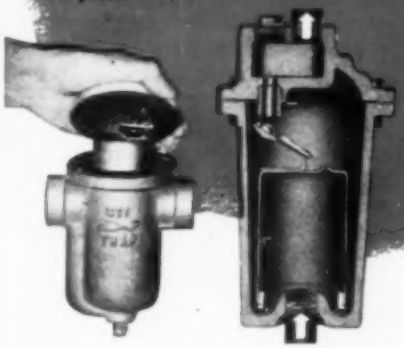
One minor repair job in twenty years—that's the record of the Armstrong traps in service at a S. Dakota hospital.

MAINTENANCE REDUCED 50%

It only takes half as much time to maintain 200 Armstrong traps at a Rochester, N. Y., photo supply as it did the traps they replaced.

10 YEARS WITHOUT REPAIRS

26 Armstrong traps on heating system service in an Atlanta building were still going strong without maintenance after 10 years.



THE MODERN ARMSTRONG TRAP

Armstrong traps are available in side inlet—side outlet and bottom inlet—top outlet models to provide the best possible installations. There is a complete line of Armstrong traps for pressures to 2400 psi., capacities to 300,000 lbs. condensate per hour.

For prices, capacities, selection and installation data consult the 36 page Armstrong Steam Trap Book. Write for a copy.

Use Armstrong Steam Traps

...they seldom need attention!

The reasons why Armstrong traps stand up so well in service and save engineers a lot of maintenance can be found in the basic design:

INVERTED BUCKET—nothing to collapse or spring a leak.

FREE-FLOATING VALVE—nothing to stick or bind.

SELF-SCRUBBING ACTION—condensate rushes and swirls through the trap carrying away dirt and scale.

CHROME STEEL VALVE AND SEAT—hardened, ground and lapped. Highly resistant to wear. Hemispherical valve seats perfectly in any position.

STAINLESS STEEL INTERIOR—valve lever and bucket assemblies are corrosion-resistant stainless.

Every Armstrong trap is inspected and tested under pressure before it leaves the factory. Trouble-free design plus quality materials plus careful workmanship plus tested performance—that's why Armstrong can guarantee "satisfaction or your money back."

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ARMSTRONG *Inverted Bucket* STEAM TRAPS

Over a Million in use for POWER, PROCESS, HEATING

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CONVENTION PAPER ABSTRACTS

CONTENTS

Oxygen in Steel Making

OXYGEN has always played a vital role in steelmaking because it combines with carbon and other elements in the molten metal during its refining in the open hearth. But the oxygen hitherto has been obtained from the air in the flame over the molten bath and considerable time elapsed before the oxygen penetrated the slag and metal. Furthermore, the concentration of the oxygen has been limited to its concentration in air, or approximately one-fifth of the air.

A new method of using oxygen to speed the refining of steel in the open hearth and increase tonnage output by 25 percent has been developed. Oxygen gas, rather than air, is introduced through a pipe below the surface of the molten metal. In this manner the concentrated gas is delivered directly and rapidly to a zone in which it does the most good. The introduced oxygen first combines with molten iron to form ferrous oxide. This compound transfers the oxygen to carbon and other elements which are to be removed from the molten iron, thereby aiding its refining into steel.

After completing the work on a series of open hearth experimental heats, it was found that the injecting of gaseous oxygen directly into the bath speeded the removal of the carbon so rapidly that 25 percent more steel can be refined as against the conventional open hearth steelmaking practices. In addition, the decreased time of making the steel did not affect its quality.

The rate of oxygen supply to the bath varied from 27 pounds (330 cubic feet) to 62 pounds (810 cubic feet) per minute. The experimental heats were made in a 90-ton furnace at Allegheny Ludlum Steel Corporation's plant at Brackenridge, Penna. Analyses were made of the carbon, manganese, phosphorus and sulphur content of the bath at suitable intervals during the oxygen "blow" and corresponding slag samples were taken and analyzed for FeO, Fe_2O_3, CaO, SiO_2, MnO, MgO, P_2O_5 and Al_2O_3. Additional heats were made using two pipes to supply oxygen simultaneously to the molten bath.

F. B. Townsberry, Allegheny Ludlum Steel Corp., and G. V. Slottman, Air Reduction Sales Co., before the American Iron and Steel Institute, New York, N. Y., May 21, 1947.

What Foremen Should Be

Too many foremen are unwisely chosen for their jobs, are inadequately trained and are not true leaders. Too little effort has been made to determine the actual qualifications of foremanship, with the result that many companies have difficulties with employees that indicate poorly qualified foremen.

We continue to suffer from a tradition that dies hard, the tradition that foremen merely need to drive and to order rather than achieve cooperation and results through leadership acquired by understanding the job and the men. Furthermore, management will do well to recognize that foremen are part of management and deserve pay and technical assistance commensurate with managerial responsibilities.

Training for foremanship should start with the men before they are foremen. Ideally it should begin in the schools and colleges, and should involve instruction in engineering principles, including shop experience, and instruction in human and public relations. After graduation, training should continue in the plant, giving prospective foremen experience in machine operation and process work, working out improved methods, personnel problems. When the time of selection comes, only those who have shown the marks of leadership, as men to whom other men look, who know how and why, and who can sell others ideas of doing things, should be selected.

Equally important as training to foremen is a degree of independence necessary to preserve their usefulness and self-respect and the respect of their subordinates. As the use of specialists in job standardization, simplification of methods and hiring and firing of men becomes more extensive in industry, care must be taken that foremen receive the benefits of specialized advice and assistance without at the same time being forced to accept arbitrary orders or endure orders passed over their heads to men in their charge.

To pick well and pay well is sound policy in acquiring qualified foremen and encouraging them to improve their work. A foreman's job is a manager's job and should be recog-

nized as such. Keep foremen informed of company developments, what the company is thinking, planning. Consult with them on policies and practices affecting their work and get their opinions. They will appreciate it even if their views are not always accepted.

W. W. Finlay, The Gulberson Corp., before the Southwest Area Conference on Industrial Relations, Houston, May 3, 1947.

Bridging Men and Management

MANAGEMENT, on the whole, has been more successful in solving problems of production than in solving those of labor. We have fallen short in the engineering of human relations. Many of us look to legislation to cure the difficulties that involve labor, and regard labor as an impersonal thing. On the other side of the gap between men and management, studies of employee opinion indicate that workers, when striving to cure real or fancied ills, look first of all to government, then to the unions, and last of all to their employers. Neither legislation nor unions, alone, is the answer to industrial strife.

The development of human relations is a challenge to management. There are four basic approaches by which this challenge can be met: (1) Determination of the needs and wants of employees, (2) establishment of a comprehensive personnel policy, (3) interpretation of the company to the employees, (4) development of a competent first line of supervision, the line where the foremen stand.

On the first point, workers want to know just what is expected of them, assurance of good pay, job security, improved working conditions. Employee polls can be highly informative, and may be taken whenever problems affecting employee relations arise. Particular care must be used in wording questionnaires and interpreting results accurately.

A comprehensive personnel policy is needed. It should include such elements as good working conditions, the publication of rules and conditions affecting the job, distribution of copies of union contracts among workers along with accurate interpretation of the contracts, publicity for employee welfare arrangements, and an effective procedure for examination and adjustment of grievances.

The third approach, interpreting the company to the employees, is important as affording the workers and the community a means of understanding the company's policies and management's objectives. Studies of a number of organizations have shown that some companies paying top wages have had poor labor relations because

the companies have not "sold" themselves properly. Interpretation involves the giving of understandable information about the company through bulletins, house organs, annual reports and advertising; expression of the position of management in contract negotiations; arrangement of meetings and outings for employees.

The gap between men and management must be bridged, in the end, by the foremen, who stand at the first line of supervision. This first line must be composed of competent men. Foremen have often been poorly trained, inadequately paid and not informed of what is going on in the company. They need to be recognized as a part of management, to receive thorough training, be permitted to attend management meetings, have their responsibilities clearly specified, given means of discussing their problems and grievances with higher officials, kept informed of company affairs and personnel policies, and be well paid.

J. Handly Wright, Monsanto Chemical Co., before the Southwest Area Conference on Industrial Relations, Houston, May 2, 1947.

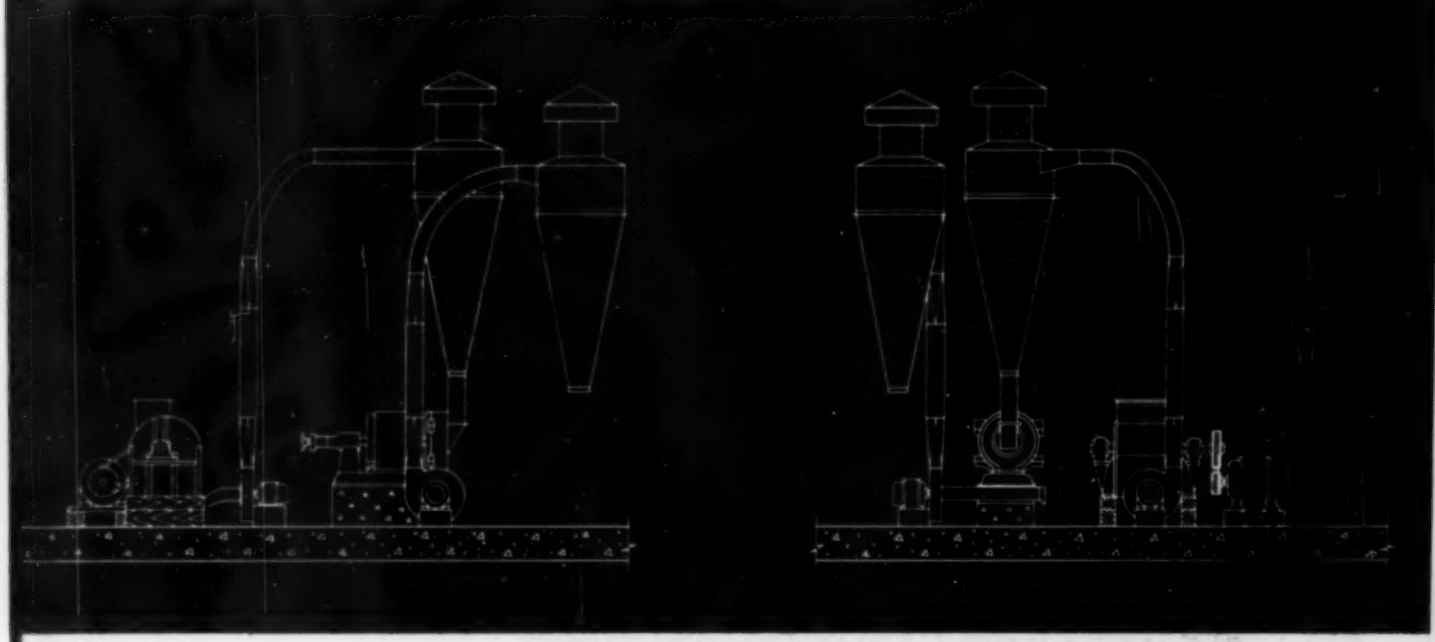
Statistical Control of Industrial Tests

Workers in the chemical industry manufacture products which they can inspect only by tests and chemical analyses. Unlike the manufacturer of automobiles or radios, the manufacturer of a chemical product cannot look at his assembly line and see the fabrication of his product. The chemical test or analysis therefore acts as a guide or compass for the manufacture of these materials, and tells when the "molecule assembly line" is not putting parts together right.

It is therefore very important that the chemist devise tests and analyses which give him the right information about his process; otherwise, he will make mistakes in controlling his process. It is not only necessary that the test be accurate and precise but it is necessary that the tests maintain this accuracy and precision at all times without error.

It is now possible, however, to measure the accuracy and precision of such control tests. It is also possible to predict the reliability of a control test and to insure that errors can be held to a minimum. This can be done by means of a statistical method known as the control chart. Brought into prominence several years ago by Dr. W. A. Shewhart, this method has been gaining prominence in many industrial plants in the control of quality. It promises to add value to the many chemical products now being

Adaptioneering AT WORK



A paper manufacturer wanted to make paper from rough rag selvage—squares, long thin strips, and circles of all types of cloth, including heavy denim. The method being used was an involved, costly process.

THE PROBLEM: To eliminate the number of steps so that a profit could be realized.

Sprout-Waldron Adaptioneering solved the problem while improving the product. Our engineers designed a procedure which effected a considerable saving in time and machinery —and which delivered a light, fluffy, shredded material with all weave removed, and with even the thread untwisted to form fluffy fibers.

THE RESULT: A great saving in time and equipment . . . a product in the half stock stage all ready for wet refining.

From candy bars to ceramics . . . from celanese to soft drinks . . . all have processing problems to be solved by Sprout-Waldron ADAPTIONEERING.

If your problem involves size reduction, mixing or blending, size separation or classification, or the handling of materials in bulk, you may realize considerable savings by consulting Sprout-Waldron. Our valuable ADAPTIONEERING service — ingenuity + machines + experience — is at your command.

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manufactured. This method allows an accurate comparison of any two methods and can select the one which will be of greater value.

It can be determined if any of the test machines are introducing abnormal errors into the test results, or if any of the analysts are causing more errors than would normally be obtained. Furthermore, it can reveal if a change in the chemicals used in the test is influencing the results.

The control chart method for controlling the accuracy and precision of a test or analysis can insure the reliability of the results obtained. It can give confidence in results and can therefore permit better process control. Better controlled processes mean better and less expensive goods for the public from the chemical industry.

James A. Mitchell, Tennessee Eastman Corp., before the Analytical and Micro Chemistry Division, American Chemical Society at Atlantic City, April 14, 1947.

Employees' Unsatisfied Needs

ALL behavior is directed toward the satisfaction of our needs. Often overlooked is the fact that employees have more than mere physical needs, that they have social needs, the urge to belong to a group, and also "ego" needs, the urge to cope with and solve problems, exercise responsibility and judgment, secure rewards for performance, to gain independence, to acquire power. When these social and ego needs are ignored and go unsatisfied, the expedient of raising wages to satisfy physical needs better offers little help in the solution of industrial relation problems. On the contrary, better pay enables men to be less preoccupied with physical needs and more conscious of the other needs and more restless if they go unsatisfied.

In the average job most workers get little chance to satisfy their social and ego urges. Management, in general, has tended to ignore or preserve this condition, with the result that many workers strive to meet these needs in devious ways that are contrary to the interests of management and production. Far different is the situation in managerial positions, where men have time and privilege to engage in the give and take of personal contact and gain recognition.

Management doesn't hire a pair of hands, but hires the whole man and his various needs. This fact must be grasped and acted upon. There is no easy, single way to do it. It is essential that management put itself in the shoes of workers and try to feel what workmen feel about their jobs. Let employees have a chance to air their views in labor relation problems, voice their ideas in questions of policy and

offer suggestions when job practices are up for review. In other words, supervision should be "consultative" to a large degree.

A difficult but unavoidable task which management faces is to find means by which the productivity of workers can be encouraged without at the same time arousing animosity and jealousy within the group. The production of high-efficiency employees must not "show up" their fellows, otherwise the most efficient workers stand in danger of social isolation on and off the job. This problem is one illustration of the reality of social needs and the importance of preserving the means of satisfying them.

Douglas McGregor, Massachusetts Institute of Technology, before the Southwest Area Conference on Industrial Relations, Houston, May 2, 1947.

Employees as Group Members

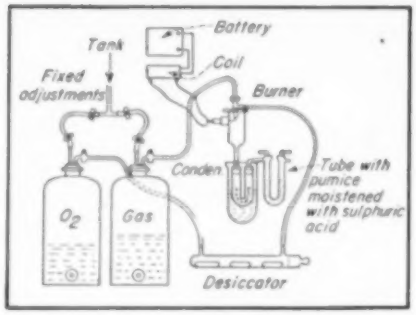
As members of social groups, employees are profoundly affected, in their attitude toward their companies, their work and their fellow workmen, by their environment on and off the job. More attention should be paid by management to the fact that group influences mold the individual for better or worse. Many workers have become adjusted, outside the plant, to what might be called a "juke box" culture: an environment in which easy money, easy beer and easy sex are regarded as the most desirable objectives in life. An alarming proportion of our industrial population is developing under slum conditions both physically and psychologically, conditions offering no incentives and providing numerous obstacles to desirable ambitions and spiritual growth.

These facts merit more attention in industrial relations. Management will find it highly worth while, from the standpoint of developing better and happier employees, to support the agencies in the community—churches, welfare organizations, schools—trying to improve living conditions. Encouragement of employees to secure decent homes in decent neighborhoods, to find wholesome recreation, and to form beneficial social groups will go a long way toward creation of better industrial relations.

During working hours wise management will find means to enable employees to feel and act like individuals, which, of course, they are. Opportunities to secure a few minutes in which to smoke, talk with officials on company affairs and future plans and discuss possible job improvements are some of these means.

R. L. Sutherland, Hogg Foundation, University of Texas, before the Southwest Area Conference on Industrial Relations, Houston, May 2, 1947.

FOREIGN LITERATURE ABSTRACTS



Determination of the Water Of Combustion of Gas

COMPLETE combustion of gas is brought about in the presence of excess oxygen (5l. of oxygen for 4l. of gas) in a Pyrex glass container at the top of which there is a burner. The absorption system includes a U-tube provided with pieces of glass tubes and immersed in melting ice. A second U-tube contains pumice moistened with sulphuric acid where the combustion products leave the water vapor with which they are saturated at the temperature of the first tube. The tubes are weighed before and after the experiment to calculate the water obtained by combustion of the gas.

Digest from "Determination of the Water of Combustion of Gas" by H. Gaudry, *J. Usines à Gaz* 70, No. 6, 75-76, 1946; *Chimie et Industrie* 57, No. 3, 256, 1947. (Published in France.)

Reaction of Vinyl Ethers and Esters with Benzene

REACTIONS of n-butyl-vinyl ether, vinyl chloride and vinyl acetate with benzene in the presence of aluminum chloride were investigated. The n-butyl-vinyl ether does not react with benzene but is converted into a polymer which reacts in part with benzene to form n-butyl benzene. Dibutyl ether reacts with benzene to form n-butyl benzene. Pyrolysis of the polymer of n-butyl-vinyl ether yields n-butyl alcohol and acetaldehyde-dibutylacetal among its products. Vinyl chloride reacts with benzene to form 1, 1-diphenylethane and 9, 10-dimethyl-9, 10-dihydroanthracene. 1, 1-Diphenylethane is converted to 9, 10-dimethyl-9, 10-dihydroanthracene by the action of aluminum chloride. Acetaldehyde reacts readily with benzene in the presence of aluminum chloride to form 1, 1-diphenylethane and 9, 10-dimethyl-9, 10-dihydroanthracene.

Digest from "Mechanism of the Friedel-Krafts Reaction. III Reaction of Vinyl Ethers and Esters with Benzene" by V. V. Korshak, K. K. Samplavskaya and A. I. Gershanovitch, *Zhurnal Obshchei Khimii* XVI, No. 7, 1065-1070, 1946. (Published in Russa).

Oxidation of Toluene

A CHLORINE-STEAM mixture was found to be a very strong oxidizing agent for toluene at high temperatures. The steam reacts with the chlorine to liberate nascent oxygen which acts as the oxidizing agent. The action of gaseous chlorine mixed with steam was therefore tested by Kreshkov on a number of organic and inorganic compounds, particularly toluene. Benzyl alcohol, benzaldehyde and benzoic acid were formed on oxidation of toluene with this mixture at temperatures from 150 to 700 deg., at an average rate of flow of toluene and chlorine of 600 cc. per minute, in the presence of various catalysts. An average of 75 percent of the toluene reacted per passage at the most favorable temperature, 360-380 deg., and the losses of toluene did not exceed 3.5 percent. The highest yield of benzyl alcohol was 12.5 percent of the reacted toluene, that of benzaldehyde 75 percent and of benzoic acid 68 percent. Benzaldehyde is converted to benzoic acid as the reaction proceeds.

Digest from "Oxidation of Toluene with a Mixture of Gaseous Chlorine and Steam to Benzyl Alcohol, Benzaldehyde and Benzoic Acid" by A. P. Kreshkov, *Promyshlennost Organicheskoi Khimii* 5, 551-553, 1938. (Published in Russia.)

Tanning with Ferric Salts

TANNING with iron appears to be more economical than vegetable tanning. The plasticity of iron-tanned leather approaches that of vegetable-tanned leather more than that of chrome leather. Iron-tanned leather can be spread more readily in the wet state, it can be beaten when dry and, finally, it absorbs a great deal of fat. The leather is treated in oil, tanned with iron, with formol pretanning followed by tanning with ferric salts (2.5 percent Fe and 4 percent trisodium phosphate) and finally neutralized with 1 percent phthalic anhydride and 0.4 percent anhydrous sodium carbonate. Neutralization is completed with sodium carbonate up to pH 4 (a total of approximately 1.5 percent Na_2CO_3). It is treated with oil in the same way as vegetable leather with a degras rich in tallow and poor in fish oil. The physical tests and the resistance to water are good. The manufacture of sole leather is more difficult if a firm leather is desired which is sufficiently thick and resists water satisfactorily. Samples prepared so far are encouraging but not entirely satisfactory.

Digest from "Tanning with Ferric Salts Considered as a Substitute for Vegetable Tanning" by P. Chambard, *Doc. Sci. Techn. Ind. Cuir* No. 9, 130-132, 1945; *Chimie et Industrie* 57, No. 2, 163, 1947. (Published in France).

CHEMICAL ENGINEER'S BOOKSHELF

Lester B. Pope, ASSISTANT EDITOR

Get Ready

THE PROBLEM OF REDUCING VULNERABILITY TO ATOMIC BOMBS. *By Ansley J. Coale. Princeton University Press, Princeton, N. J.* 116 *pages. Price* $2.

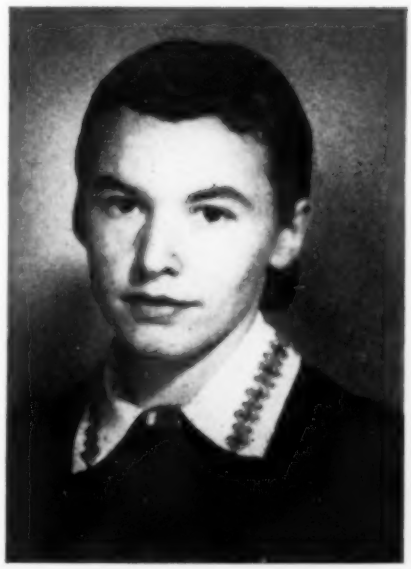
Reviewed by S. D. Kirkpatrick

IT HAS been almost two years since Hiroshima and Nagasaki, a year since Bikini. Yet surprisingly little has apparently been done to apply the obvious lessons in protection against atomic destruction. This little book, sponsored by a distinguished committee of the Social Science Research Council, is a penetrating analysis of the tremendous problems involved, and a stimulating synthesis of conditions that might exist if we fail to establish international control.

Widespread decentralization of industry or living deeply underground is not a very hopeful or practical answer. We can afford to turn to it only after we have exhausted all of the possible techniques that lie within the fields of the social sciences.

This accounts for the form and purpose of this book. Of the four principal chapters, the first describes the role of vulnerability reduction under the assumption that there is to be an effective international limit of atomic weapons. The second describes vulnerability if atomic armament continues without limitation. The third chapter is a brief but excellent summary of the technical characteristics of the bomb, with detailed appraisal of destructive possibilities of existing and improved designs, delivered by plane or supersonic rockets. The fourth chapter lists topics where research is needed and other obstacles exist to the formation of an effective program.

The social scientists responsible for this study have shown that they are ready and willing to help in solving some of the world problems that have been unleashed by the physical scientists. They do not have all the answers, of course, but this little book will aid greatly in their better comprehension and understanding by all of us.



Mrs. John R. Callaham

Russo Lingo

RUSSIAN-ENGLISH CHEMICAL AND TECHNICAL DICTIONARY. *By Ludmilla Ignatiev Callaham. John Wiley & Sons, Inc., New York.* 794 *pages.* $10.

Reviewed by J. G. Tolpin

THIS book represents a serious and successful attempt to produce a Russian-English dictionary satisfying the growing need of the English speaking scientist and technologist for such a book. Its title is partly a misnomer. Judging from the list of reference works used by the compiler and from some perusal of the dictionary this reviewer would prefer to call it a dictionary of scientific and technical terms. On the other hand, a technical dictionary usually limits itself to a definite field of science or technology in order to cover it effectively, and the emphasis on chemistry is justified, since recent surveys have shown that chemists in this country show a greater interest in the Russian technical literature than other scientists.

The considerable attention paid to engineering terms is also a desirable feature. For historical reasons the development of engineering arts and, accordingly, engineering terminologies, preceded in many cases the development of modern sciences on which these branches of engineering are based. The engineering terminologies are, therefore, more indigenous to the language in question, and while they were later permeated by a number of purely scientific and more international terms, colloquialisms and even provincial expressions are still abundantly present in them.

Examination of technical vocabularies in English has revealed frequent and wide divergencies between the connotations of numerous terms as used in "general" and in technical texts. This observation applies to all languages and is also valid for different fields of science and technology. Thus, the necessity to verify, correlate and give as many specified translations of an engineering term as the frequency of use of this term warrants becomes obvious. This seems to have been done here with sufficient discrimination. The compiler checked the meanings of the terms listed in the dictionary against varied materials, including dictionaries, and this procedure, a formidable task, yielded the more essential connotations of each term. She has also given a key to the derivation of the terms which are cognate to the corresponding English terms and has thus obviated carrying a large amount of material the omission of which does not reduce the value of the dictionary, especially considering that the more important of these cognate words are given.

If a technologist does not find in this dictionary some narrowly specialized term, it is quite probable that translation of related terms will suffice. In this connection, it must be stressed that without sufficient understanding of a technical text no good translation of it is possible anyway. A fair knowledge of the language is also required for intelligent use of a dictionary, a fact which is indicated by the author of this dictionary. For example, although a technologist will not find the translation of the expression "*soprotivlenie materialov*" (strength of materials), he will, in all probability, understand it by compar-

ing it with the term for tensile strength, "*soprotivlenie razryvu*," which is given. A Russian article on fractionation is likely to include the term "*oroshenie*," the meaning of which as "reflux," although not given, will easily be inferred from the meanings of this term which are supplied. The fact that the stressed syllable in the word is not indicated is of no consequence, since this book is not intended as an aid to speaking.

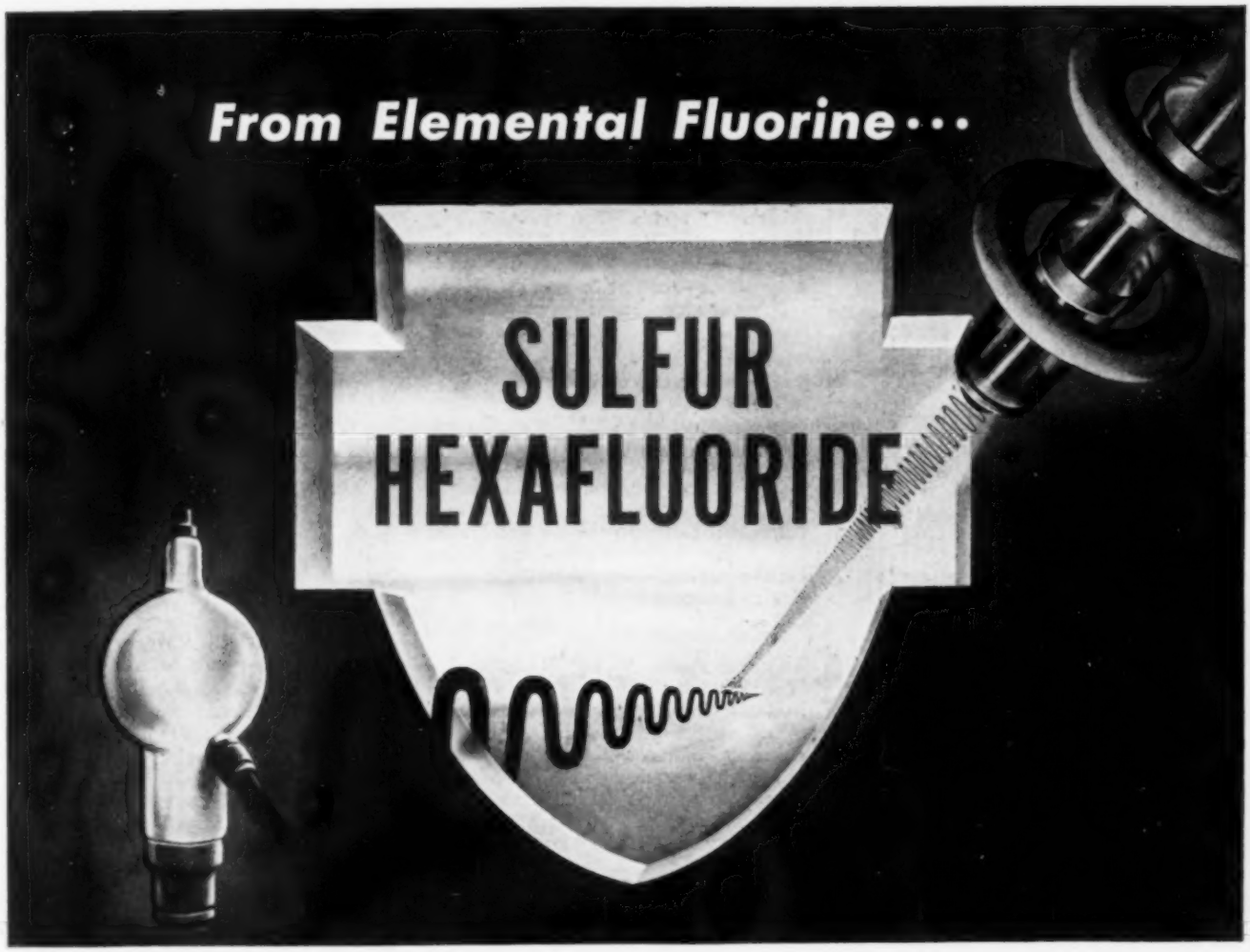
It is probable that new editions of this book will be published in the future. If suggestions for a future edition are in order, it is believed that expansion of this dictionary to include the essential terms of those fields of science which it was not intended to cover in the present edition with any degree of completeness should be considered a very worthwhile objective, particularly the biological sciences, in which the Russians are expected to produce important research data in the near future. Together with new data, new terms are introduced. In the past numerous German terms were adopted by other languages. Today the influence of American research is expressed, among other aspects, in the scientific terms evolved in this country and generally used in other languages. The term "cracking" is, to cite one example, used in German, French and Russian. Russian research, likewise, brings new terms into our vocabulary: conditioned reflex, chernozyom (black soil), antireticular cytotoxic serum and "contact" ("kontakt," a mixture of partly neutralized sulfonaphthenic acids used as a detergent, as distinguished from "contact") are examples. They have a good representation here. It would be well to aim at complete coverage of these terms, as they gain sufficient recognition. It is also advisable to cross-reference all synonyms as far as this is attainable, e.g., *repsovoe maslo* vs. *surepnoe maslo* = rapeseed oil.

The printing of this book is a very commendable job.

BRIEFLY NOTED

Marketing Drugs and Cosmetics. By L. Bader and S. Picker. Published by D. Van Nostrand Co., New York. 342 pages. $5. Organized for quick reference and direct application, this handbook describes the fundamentals of every operation in the drug and cosmetic industry. In its range are included the capital requirements in establishing a business in the field, procurement and use of research information, government regulations, methods of finance and merchandising practices.

Principles of Textile Converting. By Irving Teplitz. Textile Book Publishers, New York. 180 pages. $4. Written in non-



— A General Chemical Research Development +

SULFUR HEXAFLUORIDE

Formula: SF_6
Molecular Weight: 146.06
Melting Point: —50.8°C
Sublimation Temperature: —63.8°C
Critical Temperature: 45.6°C
Critical Pressure: 540 p.s.i.a.
Vapor Pressure:

Temp. (°C)	Pressure (p.s.i.a.)
—80	5
—50	34
—20	102
+10	240
+40	481

In Sulfur Hexafluoride, General Chemical Research makes another important contribution to fluorine chemistry. This stable dielectric gas is the first commercial chemical produced from elemental fluorine to be offered Industry . . . and fore-runner of many similarly-made fluorine compounds awaiting introduction.

Sulfur Hexafluoride was discovered by Moissan and Lebeau in 1900 as the product of combustion of sulfur in fluorine. It has been found to be remarkably inert and to possess exceptional thermal stability. These characteristics, together with its splendid electrical properties, have led to its present use as a gaseous dielectric in high-voltage equipment.

The physical data presented here may suggest other applications worthy of prompt investigation for your products and processes. For commercial quantities, experimental samples, or more detailed technical information, contact General Chemical Company, Research & Development Division, 40 Rector Street, New York 6, N. Y. Please use business letterhead when writing.

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technical language for practical converters and those who want to learn the trade. Covers organization of the textile industry, characteristics of the various fibers and yarns, construction of fabrics, converting procedures and problems, textile merchandizing, and the future of the textile industry.

(Matthews') Textile Fibers. Fifth edition. Edited by H. R. Mauersberger. John Wiley & Sons, New York. 1,133 pages. $12.50. This edition—the first revision since 1924—is not concerned with the processing of fabrics. It treats only of fibers, giving separate chapters to each and covering both natural and man-made, commercial and experimental. Each of the commercial fibers gets thorough and comprehensive examination as to physical and chemical properties, uses, adaptations, economics, microscopy, methods of testing, quantitative analysis and qualitative identification. The only criticism is that a few of the authors are not completely without prejudice in weighing the good and bad points of their specialties. The book is still the most complete and informative single volume in its field.

The New Fibers. By J. V. Sherman and S. L. Sherman. Published by D. Van Nostrand Co., New York. 537 pages. $5. Skims over the history, manufacture, properties, applications and economics of each of the important new textile fibers. Comes close to what the *Readers' Digest* might do to the chapters on synthetic fibers in the preceding book, "Textile Fibers."

The Chemistry of Heterocyclic Compounds. By Avery A. Morton. Published by the McGraw-Hill Book Co., 330 West 42nd St., New York 18, N. Y. 549 pages. $8. With the conviction that heterocyclic compounds as a class are as important as the alipathic and aromatic compounds, the author has written this text to emphasize this much-slighted branch of organic chemistry. Heterocyclic chemistry as a whole is handled as a logical extension of aliphatic and aromatic chemistry, the deviations and relationships clearly illustrated, rather than, as is usual, simply treating the better-known compounds as individual substances.

Organic Chemistry. By Paul Karrer. Published by Elsevier Publishing Co., 215 Fourth Ave., New York 3, N. Y. 953 pages. $7.50. The author has surveyed the field of organic chemistry with Teutonic thoroughness in this textbook which is the second English translation of the sixth German edition. Arranged according to their functional groups, the compounds have been dealt with as functions of the hydrocarbons. Special emphasis has been given to the chemistry of naturally occurring compounds and biochemical topics. A large number of tables embodying scientific and statistical material is appended to the book.

The Chemistry of the Carbon Compounds. Vol. III—The Aromatic Compounds. By Victor von Richter. Edited by Richard Anschutz. Elsevier Publishing Co., 215 Fourth Ave., New York 3, N. Y. 794 pages. $15. The aromatic compounds are divided according to their functional groups. Representative methods of synthesis and general reactions are given for each group and for a few of the compounds and derivatives of the group. This third English edition is based on the twelfth German edition.

ASTM Methods Chemical Analysis of Metals. Published by the American Society for Testing Materials, 1916 Race St., Philadelphia, Pa. 402 pages. $4.50. Revised and greatly expanded, this 1945 volume gives, in their latest approved form, all the methods issued by ASTM covering the chemical analysis of metals. There are 35 standards, complete coverage of the major ferrous and non-ferrous metals and alloys and several new photometric procedures.

Scientific Instruments. Edited by Herbert J. Cooper. Published by Chemical Publishing Co., 26 Court St., Brooklyn 2, N. Y. 305 pages. $6. Describing a wide variety of devices, this British publication has a scope so broad that its treatment of individual types of instruments is limited. While certain devices such as surveying instruments are treated in some detail, pressure type thermometers are barely touched upon. Main sections of the book are optical instruments, measuring instruments, navigational and surveying instruments. Some individual devices described include cameras, spectroscopes, thermometers, micrometers, mariners compass, calculating machine and vacuum tubes.

Organic Reagents for Organic Analysis. Published by Chemical Publishing Co., 26 Court St., Brooklyn 2, N. Y. 175 pages. $3.75. Compiled by the staff of the Hopkin and Williams Research Laboratory, this British publication is a reference book on the use of organic reagents in preparing derivatives of organic substances for purposes of identification by melting points. Tables of melting points and selective reagents are included.

Talbot's Quantitative Chemical Analysis. Ninth edition. Revised by L. F. Hamilton and S. G. Simpson. The Macmillan Co., 60 Fifth Ave., New York, N. Y. 439 pages. $4. Eighth revision of this 50-year-old textbook again has brought it up to date with modern theory and practice. Laboratory procedures have been rewritten and theoretical discussions have been expanded. The book now provides the basis for a course of either one or two semesters.

Ferrous Metallurgical Design. By John H. Hollomon and Leonard D. Jaffe. Published by John Wiley & Sons, 440 Fourth Ave., New York, N. Y. 349 pages, including 16-page bibliography (9,317 references) and 18-page index. $5. "Metallurgical design" here means contriving a composition and heat treatment that will produce the desired properties in a medium-alloy steel part. Chapters on phase transformation, heat flow, and mechanical behavior in steel present and organize the principles (so far as they are developed to date) which govern metallurgical design. Chapters on mechanical properties, quenching, hardenability, quench-cracking, and temperability discuss and present the data by which the

principles are applied. Two final chapters recommend a concrete procedure for using the principles and data, and give an example of its application to a specific problem.

Calculations of Analytical Chemistry. Fourth edition. By L. F. Hamilton and S. G. Simpson. Published by McGraw-Hill Book Co., 330 West 42nd St., New York, N. Y. 387 pages. $3.50. Formerly known as "Calculations of Quantitative Chemical Analysis," this textbook has been so revised as to justify its new title. Rearrangement, new sections have been added and the number of problems increased from 766 to 1,032. The book is now an adjunct to both qualitative and quantitative courses.

Organic Reactions, Vol. III. Edited by Roger Adams. Published by John Wiley & Sons, 440 Fourth Ave., New York, N. Y. 460 pages. $5. In each of its nine chapters this book discusses a widely used organic reaction from the preparative point of view. A bibliography follows each chapter as well as tables listing compounds prepared by or subjected to the reaction under discussion.

General Chemistry. Second edition. By E. P. Schoch, W. A. Felsing and G. W. Watt. Published by McGraw-Hill Book Co., 330 West 42nd St., New York, N. Y. 540 pages. 4. Having been entirely rewritten, this beginners text is essentially a new book. The revision includes a chapter on nuclear chemistry and modernized inorganic chemical nomenclature. Laboratory directions have been segregated and included in a separate laboratory manual.

Atomic Theory for Students of Metallurgy. By William Hume-Rothary. Published by Institute of Metals, 4 Grosvenor Gardens, London, S. W. 1. 286 pages. 7s.6d. Written for the advanced students and research workers in metallurgy who are interested in the new theoretical approaches to metallic structure and properties, but who are unable to understand papers and textbooks written in the language of the mathematical physicists who have done most of the theorizing. Explains the general ideas behind the new theories without getting involved in mathematical technique. Covers the historical background of the modern theory of atomic structure, the structure of the free atom and assemblies of atoms, the free electron theory of metals, and the Brillorim-zone theory of metals. Examines the structure and properties of the important groups of elements, metals, and alloys in the light of the new theories.

Smith's College Chemistry. Sixth edition. By William F. Ehret. Published by D. Appleton-Century Co., 35 West 32nd St., New York, N. Y. 677 pages. $4.75. Alexander Smith has been dead for nearly a quarter of a century but the contributions he made to chemical pedagogy are still in evidence. His textbook, in a new sixth edition, will continue to serve embryo chemists and engineers. Professor Ehret's substantial contribution has been one of modernizing a text, a job done in three previous editions by James Kendall.

RECENT BOOKS and PAMPHLETS

Bear Trap Corundum Deposit, Madison County, Montana. By John B. Hopkins and John Taber. Bureau of Mines, Report of Investigations R. I. 4039. Mimeographed.

Some Results of Inspections of Explosives-Storage Facilities Under the Federal Explosives Act. By P. R. Moyer. Bureau of Mines, Information Circular I. C. 7398. Mimeographed.

List of Publications and Patents of Bureau of Agricultural and Industrial Chemistry issued during fiscal year ended June 30, 1946. Bureau of Agricultural and Industrial Chemistry, AIC-145. Mimeographed.

Utilization of Soybean Meal in Molded Plastics. By Leonard L. McKinney. Bureau of Agricultural and Industrial Chemistry, AIC-150. Mimeographed.

The Effectiveness and Duration of Treatments with Technical DDT in Different Soils Against Larvae of the Japanese Beetle. By Walter E. Fleming and Warren W. Maines. Bureau of Entomology and Plant Quarantine, E-716. Mimeographed.

Exploration of Poor Man Iron Deposit, Kasaan Peninsula, Prince of Wales Island, Southeastern Alaska. By S. P. Holt and R. S. Sanford. Bureau of Mines, Report of Investigations R. I. 3956. Mimeographed.

Exploration of Chamberlain-Barnardville Iron Deposits, Roane County, Tennessee. By Patrick D. McMaster. Bureau of Mines, Report of Investigations R. I. 3957. Mimeographed.

Pumice and Pumicite Occurrences of Washington. By Ward Carithers. Washington Division of Mines & Geology, Olympia, Wash. 78 pages, 5 maps. 25 cents. Describes location, accessibility, physiography and other features of the principal known deposits of pumice and pumicite. Includes maps of the major areas of occurrence.

Economic Base for Power Markets in Ravalli County, Montana. By Peter F. Palmer. Div. of Industrial & Resources Development, Bonneville Power Administration, Portland, Ore. 35 pages, 20 tables. An economic study of this county, its people, agriculture, industries, public facilities, finances and other aspects. Contains statistical data.

Third Report. California State Reconstruction & Reemployment Commission, Sacramento 14, Calif. 108 pages. Reports activities of this Commission for the period 1943-1946 and summarizes the changes that have occurred in the State's population, employment, trade outlets, income, payrolls and liquid assets during the period. Considers broadly the economic outlook for 1947 and 1948.

Washington Fuel Requirements & Supplies. Information Circular 14. By R. J. Lund and John D. Sullivan. Washington Division of Mines & Geology, Olympia, Wash. Excerpts from a 369-page survey recently completed by the Battelle Memorial Institute for the State of Washington. Summarizes the requirements and supplies of coal, petroleum, electricity, wood, industrial carbon and atomic energy.

Selected List of Publications, with Abstracts. Western Regional Research Laboratory, U. S. Dept. of Agriculture, Albany 6, Calif. 66 pages. Mimeographed list of publications and articles, with abstracts, written by members of the staff of this laboratory on dehydration and freezing preservation of foods and on processing of Western agricultural wastes and byproducts.

Steel and Steel-Using Industries of California. By E. T. Grether, with collaboration of R. A. Gordon; F. L. Kidner; D. Gordon Tyndall and J. T. Nichols. Published by California State Reconstruction & Reemployment Commission, Sacramento, 14, Calif. 408 pages. $1.50 plus tax. Discusses the position, development, location, capacity, economic

handicaps and outlook of the California and Western steel and steel-consuming industries. Includes appendices with data on railways, commodities and companies.

Perlite Deposits near the Deschutes River, Southern Wasco County, Ore. By John Eliot Allen. Published by Oregon Department of Geology & Mineral Industries, 702 Woodlark Bldg., Portland, Ore. 17 pages. 15 cents. Report on the geology of perlite deposits in central and eastern Oregon, including a description of mining methods and analyses of material from one commercial mine. Contains several maps, diagrams and photographs.

San Francisco and the Bay Area, 1946. Published by the San Francisco Chamber of Commerce, San Francisco, Calif. 35 pages. Includes detailed data on conditions, civic and cultural life, populations, business and industry trends and markets in the San Francisco Bay area.

Bacterial Polysaccharides. By T. H. Evans and H. Hibbert. Scientific Report Series No. 6 published by the Sugar Research Foundation, 52 Wall St., New York, N. Y. 235 pages. A reprint from Advances in Carbohydrate Chemistry, bringing together the literature concerning dextran, the pneumococcus polysaccharides and the existing data pertaining to the less well-defined polysaccharides.

Natural Gas and the Public Interest. By F. F. Blachly and M. E. Oatman. Published by Granite Press, 1025 Connecticut Ave., N. W., Washington 6, D. C. 159 pages. $1. The factors and viewpoints of the question of administrative control are studied.

GOVERNMENT PUBLICATIONS

The following recently issued documents are available at prices indicated from Superintendent of Documents, Government Printing Office, Washington 25, D. C. In ordering publications noted in this list always give complete title and the issuing office. Remittances should be made by postal money order, coupons, or check. Do not send postage stamps. All publications are in paper cover unless otherwise specified. When no price is indicated, the pamphlet is free and should be ordered from the bureau responsible for its issue.

Expert Testimony on Technological Control of Atomic Energy Activities. Volume VII of Scientific Information Transmitted to the United Nations Atomic Energy Commission. Department of State Publication 2775. Price 15 cents.

Investigation of Government Patent Practices and Policies. Report and Recommendations of the Attorney General to the President. Department of Justice. Price $2.00.

Metallurgy: Publications by members of the staff of National Bureau of Standards (1936-1946). National Bureau of Standards, Letter Circular LC848. Mimeographed.

Cement: Publications by members of the the staff of National Bureau of Standards. National Bureau of Standards, Letter Circular LC851. Mimeographed.

Standard Samples Issued or in Preparation by The National Bureau of Standards. Supplement to National Bureau of Standards Circular C398. Available free on request to National Bureau of Standards, Washington 25, D. C.

Imports of Coal-Tar Products, 1946. U. S. Tariff Commission. Unnumbered, mimeographed.

Relation of the Suggested International Trade Organization Charter to United States Agricultural Programs. U. S. Tariff Commission, Unnumbered, mimeographed.

Agricultural, Pastoral, and Forest Industries in Argentina. U. S. Tariff Commission. Unnumbered. Price 25 cents.

Agricultural, Pastoral, and Forest Industries in Cuba. U. S. Tariff Commission. Unnumbered. Price 20 cents.

Economic Controls and Commercial Policy in Nicaragua. U. S. Tariff Commission. Unnumbered. Price 10 cents.

Federal Specification. Alcohol; Ethyl O-A-396. Price 5 cents.

Rubber: Natural, Reclaimed, and Synthetic. New Supply, Distribution, and Stocks, 1941-1946. Bureau of the Census, Facts for Industry, Series 26-1-4. Processed.

Port and Terminal Charges at United States Great Lakes Ports. War Department, Board of Engineers for Rivers and Harbors, Miscellaneous Series No. 4. Price 35 cents.

Lithology and Thickness of the Traverse Group in the Michigan Basin. By George V. Cohee. U. S. Geological Survey, Oil and Gas Investigations Series, Preliminary Chart 28. Available from the Director of the Geological Survey, Washington 25, D. C. 60 cents.

Geology of the Green River Desert-Cataract Canyon Region, Emery, Wayne, and Garfield Counties, Utah. By A. A. Baker. U. S. Geological Survey Bulletin 951. $2.

Major Winter and Nonwinter Floods in Selected Basins in New York and Pennsylvania. By W. B. Langbein and others. U. S. Geological Survey Water-Supply Paper 915. 45 cents.

Geology and Ground-Water Resources of Box Butte County, Nebraska. By R. C. Cady and O. J. Scherer. Geological Survey Water-Supply Paper 969. 70 cents.

Pacific Slope Basins in Oregon and Lower Columbia River Basin. Part 14, Surface Water Supply of the United States, 1945. Geological Survey Water-Supply Paper 1044. 50 cents.

Western Gulf of Mexico Basins. Part 8, Surface Water Supply of the United States, 1945. Geological Survey Water-Supply Paper 1038. 60 cents.

Bibliography of North American Geology, 1944 and 1945. Geological Survey Bulletin 952. $1.

Geology and Ground-Water Resources of Cedar City and Parowan Valleys, Iron County, Utah. By H. E. Thomas and G. H. Taylor. Geological Survey Water-Supply Paper 993. $1.25.

Outline of Occupational Disease Control Through Engineering. U. S. Department of Labor, Division of Labor Standards, Bulletin No. 83. Mimeographed.

Minerals Yearbook, 1945. Bureau of Mines. $4. Cloth. Separate chapters are available at prices ranging from 5 to 20 cents.

Metallurgical Research Program of the Bureau of Mines Relating to the Nonferrous Metals. By R. S. Dean and B. Silkes. Bureau of Mines, Report of Investigations R. I. 4064. Mimeographed.

Recovery of Alumina from Kaolin Employing the Lime-Soda Sinter Process. By Frank J. Cservenyak. Bureau of Mines, Report of Investigations R. I. 4069. Mimeographed.

Fluorite and Zinc on the Eva Tanguay Property, Crittenden County, Kentucky. By X. B. Starnes. Bureau of Mines, Report of Investigations R. I. 4055. Mimeographed.

Beneficiation of Western Beryl Ores. By H. D. Snedden and H. L. Gibbs. Bureau of Mines, Report of Investigations R. I. 4071. Mimeographed.

Bozeman Corundum Deposit, Gallatin County, Montana. By Robert D. O'Brien and John Taber. Bureau of Mines, Report of Investigations R. I. 4050. Mimeographed.

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You use products made better with BECKMAN pH CONTROL!

Did You Know These Beckman pH Facts?

...that Beckman pioneered modern glass electrode pH equipment, transforming the cumbersome laboratory apparatus formerly used into a compact, practical, portable instrument that paved the way for today's simplified pH measurement and control?

...that the first completely automatic glass electrode pH indicator, recorder and controller was pioneered by Beckman? Operating entirely without batteries, this instrument made automatic process control accurate, convenient, practical—and is today widely used in all parts of the world.

...that Beckman pioneered the High Temperature Glass Electrode system which, for the first time, enabled continuous pH measurements to be made at temperatures up to 212°F (100°C)? This electrode system is of tremendous value wherever hot process fluids must be controlled.

...that the High pH Glass Electrode system is also a Beckman development? This unique glass electrode unit can be used to measure high pH values even in the presence of sodium ions... and extends the usefulness and accuracy of glass electrode equipment to many industries where alkaline solutions in combination with sodium ions have heretofore presented difficulties.

...that the above are only a few of many developments that make Beckman pH Equipment the most advanced, the most accurate, the most adaptable in the field of pH?

The tires you ride on are made with the aid of Beckman pH Control. It was found that coagulation of the synthetic rubber is very sensitive to variations in the pH (acidity or alkalinity) of the processing solutions. Therefore, Beckman Automatic pH Equipment is used to control these processes for efficiency and economy.

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Are YOU Using This Cost-Cutting Tool in Your Plant?

ONLY A FEW YEARS AGO pH control was more of a laboratory curiosity than a cost-cutting industrial tool. But today—largely through the far-reaching developments of the Beckman research staff—modern pH control has become an indispensable tool for speeding chemical processes, safeguarding quality, reducing waste and simplifying production operations throughout industry. *In fact, wherever there's water there's pH...and wherever water or water processes are used, chances are the job can be done quicker, better, at lower cost with Beckman pH Control.*

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The above are but a few of the innumerable ways alert industries are cutting costs, improving product quality, reducing waste and making other vital savings with Beckman pHControl. Have you investigated the vital savings it can make in *your* operations? Our engineers will gladly study *your* pH problem and suggest ways that Beckman pH Control can save money for you. *Beckman Instruments, National Technical Laboratories, South Pasadena 14, California.*

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port of Investigations R. I. 4050. Mimeographed.

Animal and Vegetable Fats and Oils, 1942-1946. Bureau of the Census, Facts for Industry, Series M17-7-06. Processed.

Industrial Uses of Limestone and Dolomite. By Oliver Bowles and Nan C. Jensen. Bureau of Mines, Information Circular I. C. 7402. Mimeographed.

The following **Forest Products Laboratory publications,** all in mimeographed or processed form, are available only from Forest Products Laboratory, Madison, Wisconsin.

No. R444. List of Publications on Pulp and Paper, April 1947.
No. R1644. Kiln Tune-Ups to Correct Nonuniform Kiln-Drying Conditions. By Edmund F. Rasmussen.
No. R1645. Analysis of Problems Relating to Uniformity of Kiln Control. By Edmund F. Rasmussen.
No. R1661. Types of Lumber Dry Kilns. By Edmund F. Rasmussen.
No. R1668. Molecular Properties of Hemicellulose Fractions. By Merrill A. Millett and Alfred J. Stamm.
No. R1646. Dry-Kiln Building Materials and Construction. By L. V. Teesdale.
No. R1647. Economical and Efficient Kiln Operation. By W. K. Loughborough. For wood seasoning only.
No. R1648. Some Wood-Moisture Relations. By L. D. Espenas.
No. R1663. Types of Steam-Heating Systems, Flow of Steam, Cause and Effect of Air and Water Binding, Importance of Steam Traps, Steam Pressure, and Heat Transfer in Lumber Dry Kilns. By E. F. Rasmussen.
No. R1675. Pulping Characteristics of Available Lake States and Northeastern Woods. By J. N. McGovern, et al.
No. R200. List of Publications on Mechanical Properties and Structural Uses of Wood and Wood Products. April 1947.
Rept. No. R1666-15. Sawdust-Cement Concrete.
Rept. No. R1666-1. Uses for Sawdust and Shavings.
Rept. No. R1666-5. Chemical Composition and Uses of Bark.
Rept. No. R1665-6. Chemical Seasoning (of wood).

Science in Farming. The Yearbook of Agriculture, 1943-1947. U. S. Department of Agriculture. $2. Cloth. This resumes the annual Department yearbook series which has not been published since 1942.

Corn, Its Products and Uses. By J. H. Shollenberger and Carol M. Jaeger. Bureau of Agricultural and Industrial Chemistry, ACE-121, revised Feb. 1947. Mimeographed.

Farm Production, Farm Disposition, and Value of Principal Crops, 1945-1946, by States. Bureau of Agricultural Economics, Crop Reporting Board. Unnumbered, processed.

Solvent Extraction of Oilseeds. By W. H. Goss. Bureau of Agricultural and Industrial Chemistry, AIC-135. Processed.

Report on the Agricultural Experiment Stations, 1946. By R. W. Trullinger and others. 35 cents.

Clothes Moths. By E. A. Back. U. S. Department of Agriculture, Leaflet No. 145, revised January 1947. 5 cents.

Bibliography on Aviation and Economic Entomology. U. S. Department of Agriculture, Bibliographical Bulletin No. 9. 35 cents.

New Insecticides in Grasshopper Control. By E. J. Hinman and F. T. Cowan. Bureau of Entomology and Plant Quarantine, E-722. Processed.

Summary of Experiments with DDT to Control the Japanese Beetle. By Walter E. Fleming. Bureau of Entomology and Plant Quarantine, E-724. Processed.

Insecticide Duster. By R. D. Chisholm, et al. Bureau of Entomology and Plant Quarantine, ET-237. Processed.

An Exhaust Aerosol Generator for 1½ Horsepower Motors. By A. H. Yeomans and W. G. Bodenstein. Bureau of Entomology and Plant Quarantine, ET-238. Processed.

THE BEGINNING OF A NEW ERA IN THE REFINING OF GLYCERIDE OILS!

The remarkable results achieved in vitamin recovery from fish oils is but one indication of Solexol's revolutionary impact in the refining of animal, vegetable and marine oils. Production "specs" on a wide range of products are available. Write today.

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Administered by competent hands, the benefits of vitamins range from a better start in life for new-born babies to better health for grown-ups suffering from dietary deficiencies . . . *and the benefits are only beginning.*

From here on there need be no scarcity of high potency vitamin A . . . because a revolutionary new process, called Solexol, greatly increases the recovery of vitamins from existing supplies of fish oils without any processing loss whatsoever... producing in their most effective natural form, vitamins that are practically tasteless and odorless, yet chemically unchanged.

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Fish body oils and liver oils having widely different physical, chemical and vitamin-potency characteristics.

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MANUFACTURERS' LATEST PUBLICATIONS

Chemical Engineering's Readers' Service, in cooperation with manufacturers, makes it possible for you to secure catalogs, bulletins, and other publications herein listed without obligation (unless a price is specifically mentioned). For your convenience, publications may be obtained by using Reader Service Coupons on pp. 155-156.

(Continued from page 156)

Sons, Inc., New York, N. Y.—16-page booklet describing building materials, such as concrete floor treatment, wood floor treatment, waxes, concrete and water admixtures, waterproofing and damp-proofing compounds, paints and protective coatings, roof coatings and caulking compounds. Contains a number of application suggestions.

111. Protective Coatings. Bradley Paint Engineers, Inc., Pittsburgh, Pa.—8-page pocket size booklet describing the products and facilities of products and service offered by this company.

112. Heat Treating. Surface Combustion Corp., Toledo, Ohio—Bulletin SC-134 is a 16-page bulletin entitled "Modern Gas Carburizing Processing and Equipment," describes how modern gas carburizing is accomplished, and explains the related processes of suspended carburization, carbon restoration, and dry cyaniding. It is well illustrated with graphs, charts and tables.

113. Magnesium Salt. Marine Magnesium Products Corp., San Francisco, Calif.—A process for recovering magnesium salt from seawater is illustrated and described in a pictorial flowsheet. Contains the history of the development of this company and includes a report to the stockholders and customers of this company.

114. Protective Coatings. Maas & Waldstein Co., Newark, N. J.—Complete new catalog on the lacquers, enamels and synthetics manufactured by this company.

115. Materials Handling. Link-Belt Co., Chicago, Ill.—20-page booklet No. 2048A illustrates and describes this company's rotary dumpers for mine cars and railroad cars. Details of construction and operation are well illustrated by photographs, diagrams and sectional views.

116. Safety Equipment. Mine Safety Appliances Co., Pittsburgh, Pa.—Four-page leaflet featuring the MSA carbon monoxide alarm for use where carbon monoxide concentrations may become dangerous.

117. Instruments. Fischer & Porter Co., Hatboro, Pa.—Catalog No. 25E is a 24-page booklet describing the Florator instrument manufactured by this company.

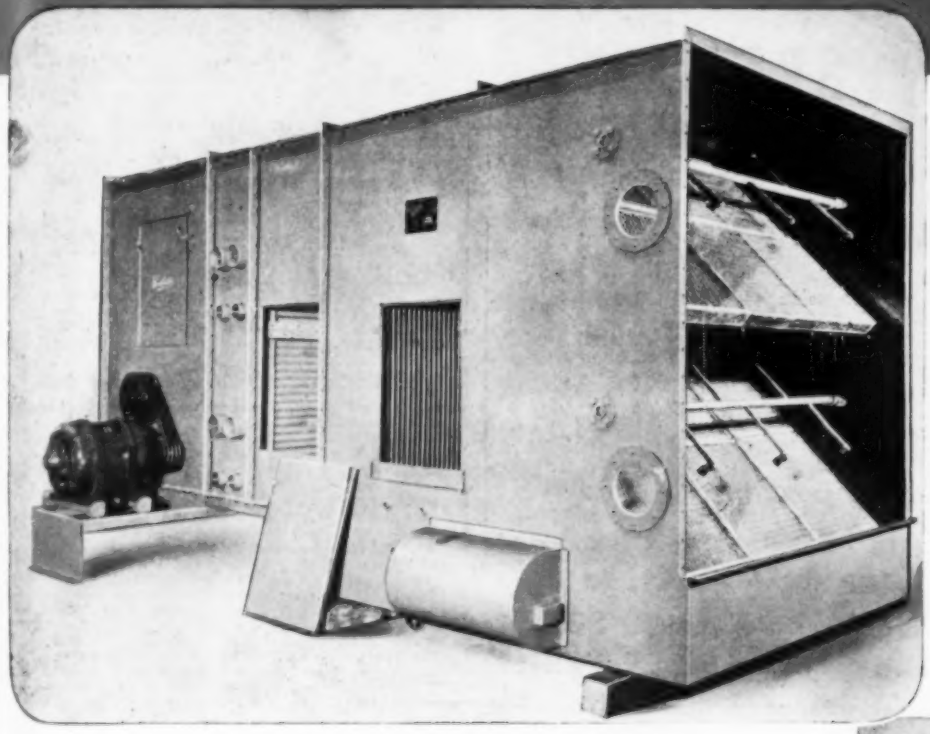
118. Chemicals. B. F. Goodrich Chemical Co., Cleveland, Ohio—Technical Bulletin 47-SB2 gives detailed chemical and physical properties of Rhodanine (2-thio-4 keto-thiazolidine) manufactured by this company.

119. Centrifugal Pump. National Transit Pump & Machine Co., Oil City, Pa.—Bulletin 6000. 8-page illustrated brochure describing the centrifugal pump made by this company. Detailed specifications are included, construction features are illustrated by cutaway views.

120. Lumber Products. Timber Engineering Co., Washington, D. C.—40-page booklet entitled "Modern Building With Wood" illustrates a wide variety of structures of wood.

121. Protective Coatings. Armour & Co., Chicago, Ill.—4-page leaflet entitled "Sur-

CLEAN AIR with HUMIDITY and TEMPERATURE CONTROL at MODERATE COST!



● "Buffalo" Wet Glass Cell Air Washer, showing spray banks and filter packs at front.

● Here's triple-process air conditioning for product quality control as well as health, comfort and efficiency in your personnel!

"Buffalo" Wet Glass Cell Air Washers do this to your air:

(1) Remove 98.5% of the visible dust, and other air-borne impurities.

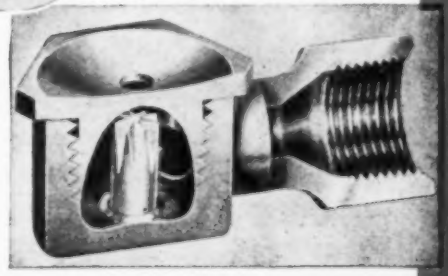
(2) Humidify your air to the exact degree you require—and hold humidity at that point.

(3) Heat to desired temperature, by efficient heating coils through which air passes.

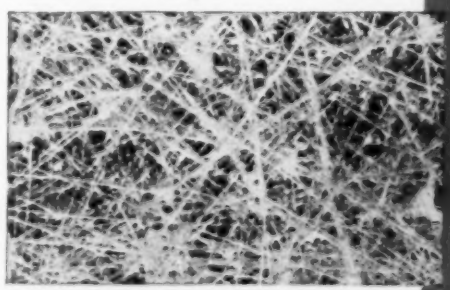
(4) Cool—by means of chilled water, in sprays or by means of cooling coils.

—at moderate cost: "Buffalo" Wet Glass Cell Air Washers are not difficult to install, and fan and pump power requirements are low.

WRITE FOR BULLETIN 3457. **It gives you facts to help you choose the most economical, effective unit for your particular need.**



● Atomized curtains of spray from improved "Buffalo" nozzles such as the above, "bathe" the passing air constantly and thoroughly.



● The "heart" of a "Buffalo" Wet Glass Cell air cleaning process is this fine, closely intermeshed glass fibre which "scrubs" off the dirt as the air passes through.

BUFFALO FORGE COMPANY

501 BROADWAY BUFFALO, N. Y.

Canadian Blower & Forge Co., Ltd. Kitchener, Ont.

"Buffalo"

WET GLASS CELL AIR WASHERS

face Treatment With Armeens and Armacs." Contains information on the use of aliphatic amines and their acetate salts in changing the surface characteristics of various materials.

122. Control Panel. Holophane Co., Inc., New York, N. Y.—24-page booklet which outlines methods on the lighting of control panels and of all vertical systems, such as light boards, bulletin boards.

123. Chemicals. Hercules Powder Co., Wilmington, Del. — 20-page illustrated brochure featuring CMC (sodium carbohymethylcellulose) and other chemicals made by this company. This booklet is the No. 17 issue of the Hercules Chemist.

124. Materials Handling. Convair Corp., Pittsburgh, Pa.—Bulletin No. 101 is an 8-page booklet describing this company's pneumatic conveying systems for the chemical, food, glass, steel allied industries. Contains installation diagrams for a number of industrial purposes.

125. Foundry Equipment. Hauck Mfg. Co., Brooklyn, N. Y.—Catalog No. 1043 is a 12-page illustrated booklet describing the oil- and gas-burning equipment made by this company.

126. Chemicals. Monsanto Chemical Co., St. Louis, Mo.—32-page booklet describing the preparation of phosphorus and phosphorus compounds. Contains flow diagrams and pictures and gives a rather complete history of the development of phosphorus production.

127. Protective Coatings. Walles-Dove-Hermison Corp., Westfield, N. J.—4-page leaflet featuring the application of Koppers Bituplastic, a plastic protective coating.

128. Instruments. American Instrument Co., Silver Springs, Md.—88-page Catalog No. 406 entitled "Superpressure Catalytic Hydrogenation Apparatus" includes a discussion of high-pressure processes, a presentation of typical high-pressure flowsheets, and a detailed description of apparatus used in high-pressure and high-temperature technique.

129. Instruments. Northern Equipment Co., Erie, Pa.—Bulletin No. 469 is a case history of the application of this company's boiler water level control at the Virginia Electric & Power Co.

130. Refractories. The Ironton Fire Brick Co., Ironton, Ohio—4-page leaflet describing iron Zerlite refractory materials.

131. Acetylene Generators. Air Reduction Sales Co., New York—22-page catalog listing and describing the complete line of Airco acetylene generators. Also contains information on this company's manifold for both oxygen and acetylene cylinders.

132. Odor Control. Cargille Scientific Inc., New York, N. Y.—12-page booklet entitled "Scientific Odor Control," which describes the principle of this company's odor control system.

133. Expansion Joints. American District Steam Co., N. Tonawanda, N. Y.—8-page illustrated bulletin No. 35-30D, describes the Adsco internally guided expansion joint for steam, water, oil and other pipe lines. Gives details of construction, dimensions and list prices.

134. Instruments. The Bristol Co., Waterbury, Conn.—12-page Bulletin No. C305 illustrates and describes this company's new line of Model C500 impulse, sequence and time cycle controllers. Gives information on the principle of operation and its method of use on typical plant processes.

135. Heat Exchangers. Duriron Co., Inc., Dayton 1, Ohio—4-page illustrated booklet No. 1603 describes Dorco heat exchangers for heating and cooling corrosive liquids.

136. Grinders. The Jeffrey Mfg. Co., Columbus, Ohio—Bulletin No. 796 contains eight pages describing and illustrating this company's garbage grinders for municipal grinding plants.

137. Freeze-Drying Equipment. F. J. Stokes Machine Co., Philadelphia, Pa.—20-page illustrated booklet, Catalog No. 455A, describing the freeze-drying equipment manufactured by this company. Contains a number of illustrations showing different applications.

138. Wire Screens. John A. Roebling's

Sons Co., Trenton, N. J.—Catalog W-903 is a 12-page booklet featuring the different types of wire screen made by this company. Screen construction is shown by photographs.

139. Conduit. Ric-wil Co., Cleveland, Ohio—4-page leaflet featuring the tile and cast iron conduit systems for use in underground insulated pipe systems.

140. Metal Cutting. Arcos Corp., Philadelphia, Pa.—4-page folder featuring this company's oxyarc process and process for cutting stainless and alloy steels and non-ferrous metals.

141. Flexible Shafting. Wyzenbeek & Staff, Chicago, Ill.—32-page illustrated catalog showing the complete Wyco line of flexible shaft equipment.

142. Lifting Jacks. Templeton, Kenly & Co., Chicago, Ill. — Engineering Data Bulletin featuring this company's Simplex jacks for use in supporting and leveling tanks.

143. Refractories. Laclede-Christy Clay Products Co., St. Louis, Mo.—40-page illustrated brochure featuring this company's plastic fire brick and its application. Contains many illustrations of furnaces and other equipment which use refractories, and shows how this type of refractory is installed.

144. Insulating Varnish. Irvington Varnish & Insulator Co., Irvington, N. J.—A wall chart giving essential physical, chemical and electrical data on this company's insulating varnishes. Lists suggested uses for the varnishes described, and gives other useful information.

145. Textile Chemicals. American Cyanamid Co., Bound Brook, N. J.—Textile Finishing Bulletin 117 describes Aerotex Accelerator T, a curing catalyst for amino-formaldehyde resins.

146. Valves and Fittings. Alloy Steel Products Co., Inc., Linden, N. J.—Catalog No. 47 contains 54 pages and gives a complete description of all standard Alloyco corrosion-resistant valves and fittings, together with photographs and cross-sections, dimensional data and list of alloys in which each style is stocked. Lists specific alloy recommendations for handling nearly four hundred different corrosive solutions.

147. Sulphur Dioxides. Ansul Chemical Co., Marinette, Wis.—Bulletin describing a method for the preparation of continuous sulphur dioxide and water solutions at any predetermined concentration.

148. Tubing. Babcock & Wilcox Co., New York, N. Y.—10-page illustrated bulletin on the new 9 percent nickel steel tubing now available from this company. Describing the mechanical and working characteristics, heat treating behavior, and weldability of these tubes.

149. Pulp and Paper Engineers. Frederick B. Clark Associates, New York, N. Y.—12-page booklet describing the services offered by this company to the pulp and paper industry. Contains a list of this company's key personnel.

150. Chemicals. E. I. du Pont de Nemours & Co., Inc., Wilmington, Del.—42-page booklet entitled "Stories About Chemistry From the Du Pont Cavalcade of America."

151. Steam Engines. Troy Engine & Machine Co., Troy, Pa.—Bulletin No. 307 contains seven pages illustrating and describing the steam engine drives made by this company. Both horizontal and vertical steam engines are shown.

152. Protective Coatings. American Chemical Paint Co., Philadelphia, Pa.—Technical Service Data Sheet No. P-100-21. 8-page booklet describing this company's line of coatings which include rustproofing chemicals, protective coatings, metal cleaning chemicals and inhibitors.

153. Heat Treatment Chemicals. American Cyanamid Co., New York, N. Y.—38-page booklet describing the salt batch heat treating chemicals made by this company. A section is given to the description of all modern salt baths which were developed.

154. Air Compressor Equipment. Worthington Pump & Machinery Corp., Harrison, N. Y.—Bulletin H-620-B26 illustrates and describes this company's air compressors, while Bulletin L-802-B2 contains

BLOWERS
COMPRESSORS
VACUUM PUMPS

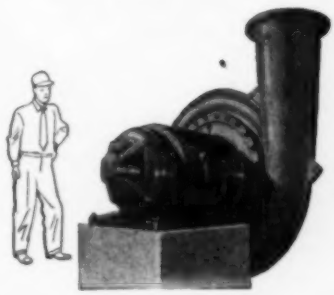
Your Process Tells the Story!

WHETHER your process calls for aeration, agitation, circulation or combustion, Allis-Chalmers offers five types of air and gas handling equipment. It builds them standard or special to suit your needs.

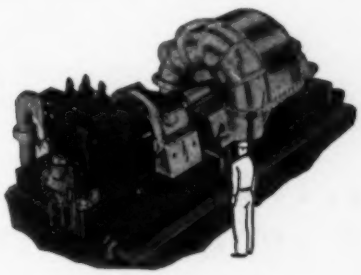
You give us such information as: If gas, is it saturated, dry, corrosive or non-corrosive? What volume is to be handled? Specific gravity? Inlet temperature? What discharge pressure? Parallel or single operation? Automatic or manual control? Type of drive?

Our engineers will recommend equipment to fit exactly your job! Allis-Chalmers in conjunction with process engineers has developed turbo-blowers, rotary compressors and vacuum pumps to suit *special* process applications. It offers 50 years of experience in this field!

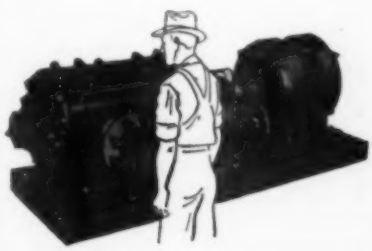
A qualified sales engineer in our nearby office is available to discuss your problems with you. ALLIS-CHALMERS, MILWAUKEE 1, WIS.



SINGLE STAGE BLOWERS. Pressure ranges from one to 6.50 lbs. Features: Discharge nozzle can be arranged 24 ways. Cast casing provides rigidity, longer life, smoother operation . . . deadens machine noises, eliminates vibration.



MULTI-STAGE BLOWERS. Inlet volumes to 130,000 cfm, pressure to 35 lbs G, uncooled. Centrifugal type, for boosting, exhausting, circulating. Cannot build up dangerous pressures. Pressure volume curve favorable to parallel operation.



ROTARY COMPRESSORS, sliding vane type. Capacities for 5 to 35 psig. Air is compressed in cells formed by blades moving freely in and out of longitudinal slots in rotor. Quiet, smooth operation. Notably low maintenance. Unit start unloaded.

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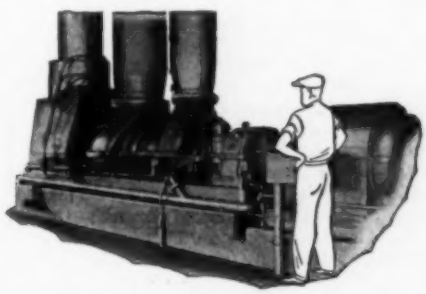
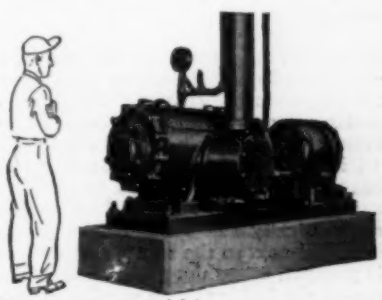


AXIAL COMPRESSORS. Compress to 60 lbs. gauge with high efficiencies. *Good base load machines.* Handle large fixed volumes with pressure variations over a comparatively wide range. Used in connection with *gas turbines.* Cannot build up dangerous pressures.



DRY VACUUM PUMPS. Range to 28½ inches hg vacuum. Same principle as rotary compressors except that inlet is hooked up to chamber to be evacuated and exhaust is open. Operates free of vibrations or pulsations. No inside valves. Saves floor space.

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One of the Big 3 in Electric Power Equipment — Biggest of All in Range of Industrial Products

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A CENTURY OF SERVICE
to Industry
THAT MADE
America Great

FOR MORE INFORMATION
See Reader Service Coupon on pages 155-156

8 pages featuring aftercoolers for air and gas. Different models and hookups are illustrated.

155. Instruments. Taber Instrument Corp., North Tonawanda, N. Y.—3 new bulletins have been issued by this company. One describes the thermocreaser for speed-creasing sheet plastics. The second of these features the Model 100-108 vacuum pick-up attachment for abrasion testing. The third of these describes three new abraser accessories namely: the interval timer, the duplex refacing stone, and the abraser drymount.

156. Thermocouples. Thermo Electric Co., Fairlawn, N. J.—30-page booklet illustrating and describing the equipment made by this company including thermocouples, coupling connectors, protection tubes, lead wires, accessories, pyrometers, and industrial furnaces. The various types of equipment are well illustrated.

157. Neoprene Hose. E. I. du Pont de Nemours & Co. Inc., Wilmington, Del.—8-page bulletin entitled "The Effect of Fuels Containing Aeromatic Hydrocarbons on Neoprene Hose".

158. Adhesives. Casein Co. of America, Div. of the Borden Co., New York, N. Y.—Gluing chart describes the required properties of glues for various jobs and lists the glues recommended for each job.

159. Metal Cleaning. American Chemical Paint Co., Ambler, Pa.—4-page folder featuring deoxidine for removing rust and cleaning metals prior to painting.

160. Tables. Montgomery & Co., Inc., New York, N. Y.—2-page leaflet featuring the portable industrial elevating table available from this company.

161. Pumps. Peerless Pump Div., Food Machinery Corp., Los Angeles, Calif.—Bulletin B-148. 24-page illustrated booklet describing the Hydro-Foil pumps made by this company. These are vertical water pumps of the propeller and mixed flow types. Sectional views show principles of construction. A number of photographs are shown illustrating different applications.

162. Electronic Tubes. Westinghouse Electric Corp., Pittsburgh, Pa.—25-x36 in. wall chart printed in several colors on heavy linen paper illustrates and describes in detail principle of operation of electron tubes.

163. Compressors. Clark Bros. Co. Inc., Olean, N. Y.—12-page reprint which describes the pressure maintenance and cycling operations in the cotton valley gas fields of North Louisiana.

164. X-Ray Equipment North American Philips Co., Inc., New York, N. Y.—2 leaflets entitled Metallurgical Applications of the X-Ray Diffraction Spectrometer" and "Sampling Techniques Applied to Quality Control".

165. Refrigeration Equipment. Worthington Pump & Mfg. Co., Harrison, N. J.—4 booklets illustrate and describe some of the equipment made by this company for use in refrigeration work. Bulletin C-1100-B42 and Bulletin C-1100-B43 describe Freon condensing units. Bulletin H-620-B26 illustrates and describes this company's air compressors.

166. Protective Coatings. National Marine Paint Co. Inc., New York, N. Y.—4-page folder featuring this company's aluminum paints.

167. Protection Controls. Viking Instruments, Inc., East Haddan, Conn.—32-page catalog describing and illustrating the protective equipment for internal combustion engines. Contains information on safety controls, alarm systems, indicator systems and automatic plant equipment for stationary, locomotive, marine and industrial application.

CHEMICAL ECONOMICS

H. M. Batters, MARKET EDITOR

CHEMICAL INDUSTRY ENTERS SECOND HALF OF YEAR WITH VERY LITTLE DROP FROM ITS PEAK LEVEL

PRODUCTION OF industrial chemicals in the first six months of this year appears to have been a little more than 12 percent over that for the corresponding months of last year with domestic consumption registering a gain of approximately 13 percent for the same periods. Production data are based on the indexes of the Federal Reserve Board and the status of consumption is measured by the *Chemical Engineering* index for industrial consumption of chemicals. The time lag in collecting statistics may bring some modifications in the indexes for May and June but, in all probability, revisions will be slight and will not materially affect the averages as they are now indicated.

Hence, the chemical industry has entered the second half of this year at a level about 10 percent higher than a year ago, based on a comparison of current rates and those of July 1946. In the latter part of 1946, the trend for both production and consumption of chemicals was upward and it is not to be expected that the rate of gain made in the first half of the year will be maintained throughout the 12 months.

The position of some consuming industries has changed since last January. At the beginning of the year, many chemicals were in short supply and inventories of finished products were below normal. As the year advanced, the supply situation improved and reserve stocks began to accumulate with the result that buying in some quarters was restricted to current requirements. For instance, production has been curtailed at some textile mills and at some glassware plants. Sales of paints in the first four months were of record proportions but consumption did not keep pace with sales and the tempo slowed in May in order to bring a better balance between supply and demand. In short, soft spots have developed within the chemical industries as well as in lines which offer important consuming outlets. Furthermore a degree of caution has been added because of declining prices.

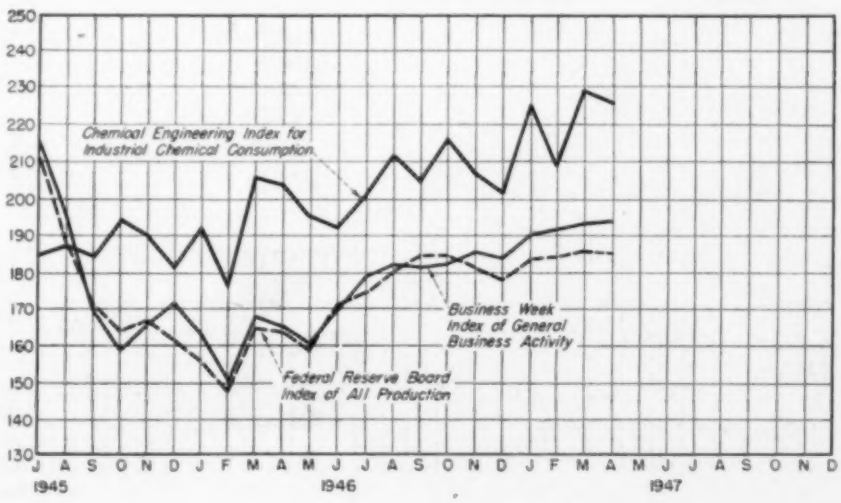
On the other hand, there has been no general drop in activities in the chemical process industries, many chemicals are still in short supply, and some consuming outlets are more active than they were in the earlier months of the year. Consumption of rubber was a little larger in April than it was in March. In the first four months of the year, consumption of rubber was 359,798 long tons, of which only about 56 percent was synthetic whereas in corresponding months of 1946, consumption was 325,872 long tons with synthetic representing more than 84 percent of the total.

Chemical Engineering Index
Industrial Consumption of Chemicals
1935 = 100

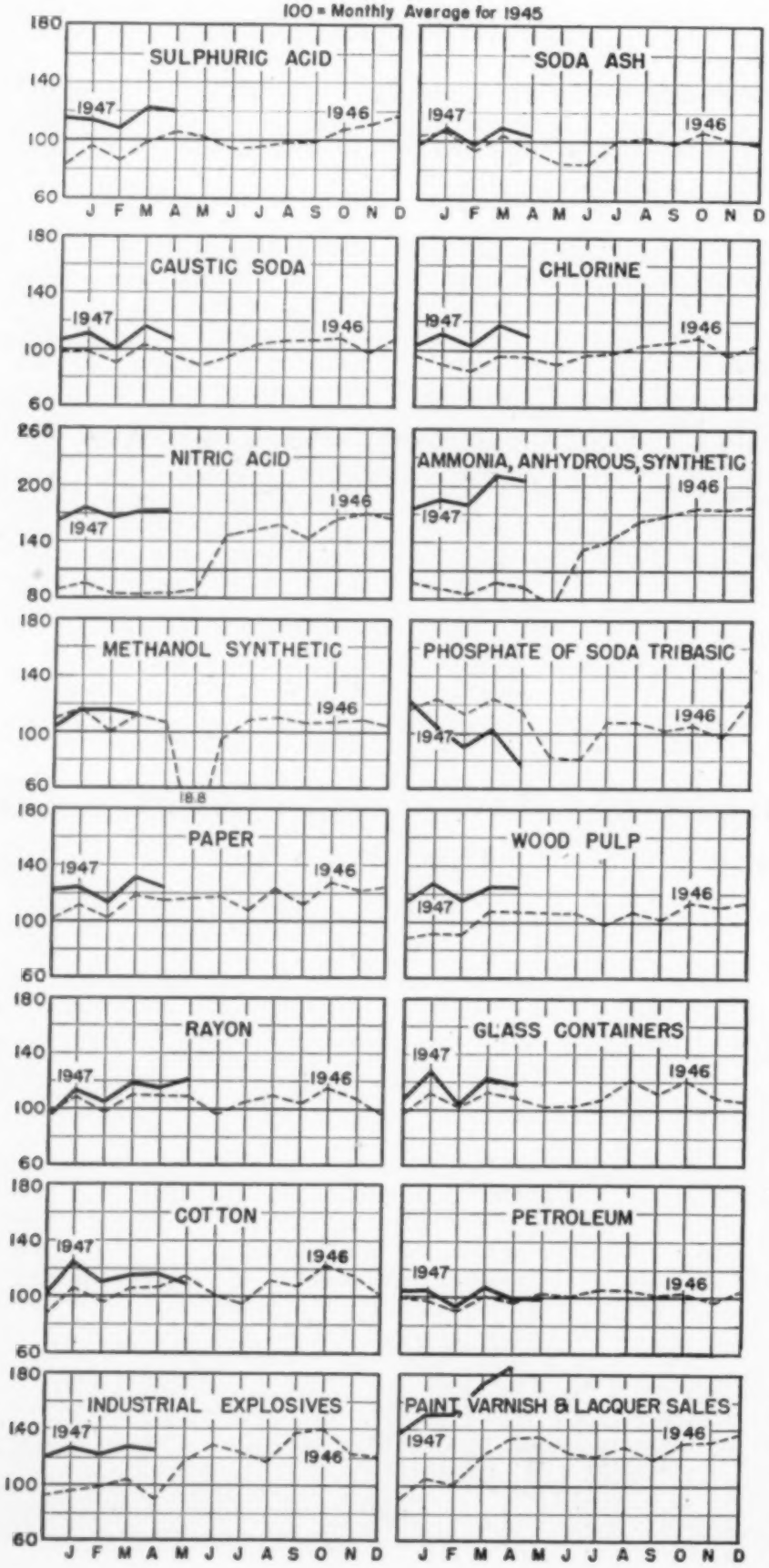
	March Revised	April
Fertilizers	52.96	51.40
Pulp and paper	23.50	22.90
Petroleum refining	19.82	18.51
Glass	23.60	22.87
Paint and varnish	25.41	27.47
Iron and steel	13.62	13.09
Rayon	22.55	22.11
Textiles	11.90	11.85
Coal products	10.70	9.70
Leather	4.70	4.60
Explosives	6.80	6.74
Rubber	6.45	6.45
Plastics	7.74	7.53
	229.75	225.84

Fertilizer tag sales in May were the equivalent of 644,000 tons, a new all-time high. At the meeting of the National Fertilizer Association, held last month, it was stated that fertilizer production for the 1947-48 season may be 8 percent higher than in the 1946-47 fiscal year. Of the three major materials nitrogen production is expected to increase 9 percent, phosphate 10 percent, and potash about 3 percent. If these expectations are realized, the heavily weighted fertilizer chemicals will be important in maintaining a high average production level.

In the meantime, the longer-term trend for chemicals is indicated by the regularity with which reports are heard regarding programs for new plants and plant expansions as well as by the constant commercial introduction of new products which entail the use of chemicals. Last month War Assets Administration announced that war-production units having a total yearly rated capacity of 991,250 tons of 100 percent sulphuric acid had been sold or leased to date. Disposal of the 73,000 ton plant at Baraboo, Wis., is pending and six more plants with a combined rated capacity of 547,000 tons, are available for sale. Some of these facilities formerly were parts of ordnance or explosives plants and have been placed in operation to meet local requirements for superphosphate, production of which had been held in checks either because of the scarcity of sulphuric acid or because any acid available was held at distant points.



PRODUCTION AND CONSUMPTION TRENDS



ACCORDING TO the indexes of the Federal Reserve Board, production of industrial chemicals has been moving upward with the number for April higher than those for the preceding months. The detailed report shows that some of the agricultural chemicals were turned out in larger volume in April but most of the heavy tonnage chemicals were off a little with a drop of about 70,000 tons in sulphuric acid production from March through April. Throughout the list, however, monthly changes in output have not varied much if consideration is given to the difference in number of working days.

Prices for oils and fats continue to decline as larger offerings come upon the market and predictions that this trend has not run its course, still are regarded as sound. Price changes in chemicals are noted in both directions with revisions based on particular conditions rather than on any general trend. As a case in point, strength in the metal market has brought an advance in sales prices for cobalt oxide while a drop in the silver market has brought out lower prices for silver nitrate. Prices for some of the coal-tar products are firm with upward revisions probable. Apprehension is voiced regarding the possibility of work stoppages at coke plants but in any event higher prices for coal and coke are regarded as certain.

In general, the price situation is affected by the gradual catching up of supply with demand and the establishment of competitive selling which may or may not lead to lower prices. Where larger offerings are accompanied by lower production costs, prices for the finished products involved turn in buyers favor but in the chemical field, production costs are holding up and this discourages belief that any general price decline is imminent.

The Bureau of Mines has just reported that production of carbon black last year reached the record total of 1,244,421,000 lb. which is 18 percent above the 1945 output. Yet this record production was not sufficient for consuming requirements and stocks had to be drawn upon in order to round out consumers needs. This is one of several instances where production was of record volume and did not result in building normal reserve stocks. Demand for carbon black may be smaller this year but certainly not changed enough to put any check on production.

United States Production of Certain Chemicals

April 1947, April 1946 and Four-Month Totals for 1947 and 1946

Chemical (Tons unless Otherwise noted)	April 1947	April 1946	Total, Four Month 1947	Total, Four Month 1946
Ammonia, synthetic, anhydrous[1]	93,007	43,358	356,650	168,751
Ammonium nitrate (100% NH_4NO_3)	87,042	42,680	351,192	143,781
Ammonium sulphate, synthetic technical (M lb.)	31,121	24,602	117,163	108,366
Calcium arsenate ($Ca_3As_2O_8$) (M lb.)	2,320	3,256	6,849	6,957
Calcium carbide, commercial	51,530	40,014	200,382	169,982
Calcium phosphate:				
Monobasic (100% $CaH_4(PO_4)_2$) (M lb.)	6,178	5,158	25,702	23,679
Dibasic (100% $CaHPO_4$) (M. lb.)	.....	.....	.....	.....
Carbon dioxide:				
Liquid and gas (M lb.)	17,021	17,149	64,389	68,169
Solid (M lb.)	64,309	58,185	189,739	182,856
Chlorine	109,034	94,865	437,872	365,752
Chrome green (C.P.) (M lb.)	1,312	1,649	4,531	7,081
Chrome yellow and orange (C.P.) (M lb.)	4,144	4,129	14,521	17,632
Hydrochloric acid (100% HCl)	34,637	26,867	140,740	107,291
Hydrogen (M cu. ft.)	1,504	1,385	6,402	5,693
Lead arsenate, acid and basic (M lb.)	5,470	8,665	18,565	31,408
Molybdate chrome orange (C.P.) (M lb.)	424	469	1,683	1,815
Nitric acid (100% HNO_3)	64,288	31,311	255,266	128,102
Oxygen (M cu. ft.)	1,146,000	886,000	4,475,000	3,158,000
Phosphoric acid (50% H_3PO_4)	83,074	75,640	325,942	302,917
oda ash:				
Ammonia-soda process:				
Total wet and dry[2]	367,847	342,749	1,481,823	1,452,875
Finished light[2]	175,824	172,630	722,505	720,373
Finished dense	131,850	117,344	532,904	513,229
Natural[3]	22,991	15,715	83,356	64,931
Sodium bicarbonate, refined	16,727	17,444	64,112	64,745
Sodium bichromate and chromate	7,089	7,837	27,151	30,583
Sodium hydroxide:				
Electrolytic process:				
Liquid[4]	103,716	92,396	426,332	353,405
Solid	16,948	15,844	79,843	63,741
Lime soda process:				
Liquid[4]	63,214	58,936	252,233	255,783
Solid	20,736	17,813	80,694	76,657
Sodium phosphate:				
Monobasic (100% NaH_2PO_4)	1,090	1,054	4,704	4,399
Dibasic (100% Na_2HPO_4)	5,539	5,961	24,767	22,924
Tribasic (100% Na_3PO_4)	8,540	8,538	27,623	35,448
Meta (100% $NaPO_3$)	1,585	2,294	8,938	9,629
Tetra (100% $Na_4P_2O^7$)	4,181	4,935	16,435	19,035
Sodium silicate, anhydrous	50,267	29,914	168,272	127,069
Sodium sulphate:				
Anhydrous, refined	12,529	10,985	47,440	42,987
Glauber's salt[5]	17,612	13,465	70,535	54,289
Salt cake, crude, commercial[5]	51,606	46,060	198,225	169,703
Sulphuric acid:				
Chamber process	272,099	273,030	1,149,440	1,018,099
Contact process, new	547,322	470,884	2,181,337	1,842,642
Zinc yellow (zinc chromate) (C.P.)	191	85	964	.....

Data for this tabulation have been taken from "Facts for Industry" series issued by Bureau of the Census. Production figures represent primary production and do not include purchased or transferred materials. Quantities produced by government-owned arsenals, ordnance works, and certain plants operated for the government by private industry are not included. Chemicals manufactured by TVA, however, are included. All tons are 2,000 lb. Where no figures are given data are either confidential or not yet available. [1] Includes a small amount of aqua ammonia. [2] Total wet and dry production, including quantities diverted for manufacture of caustic soda and sodium bicarbonate, and quantities processed to finish light and finished dense. [3] Not including quantities converted to finish dense. [4] Data collected in cooperation with the Bureau of Mines. [5] Figures represent total production of liquid material, including quantities evaporated to solid caustic and reported as such. [6] Includes oleum grades, excludes spent acid. [7] Data for sulphuric acid manufactured as a byproduct of smelting operations are included. [8] Revised.

United States Production of Certain Synthetic Organic Chemicals

March 1947, February 1946 and Three-Month Totals for 1947 and 1946

Chemical	March 1947	March 1946	Total, Three Months 1947	Total, Three Months 1946
Acetanilid, technical and U.S.P	883,338	606,068	2,170,570	1,777,581
Acetic acid:				
Synthetic[1]	31,463,095	25,008,262	93,146,151	65,896,788
Recovered	125,981,430	97,071,475	355,116,816	281,244,379
Natural[2]	2,156,435	1,738,155	6,294,697	5,434,582
Acetic anhydride[3]	54,206,388	44,026,772	149,026,155	128,090,245
Acetone	30,301,833	27,981,806	89,899,662	80,661,780
Acetylsalicylic acid	831,606	976,421	2,780,878	2,806,631

(*Continued on page 294*)

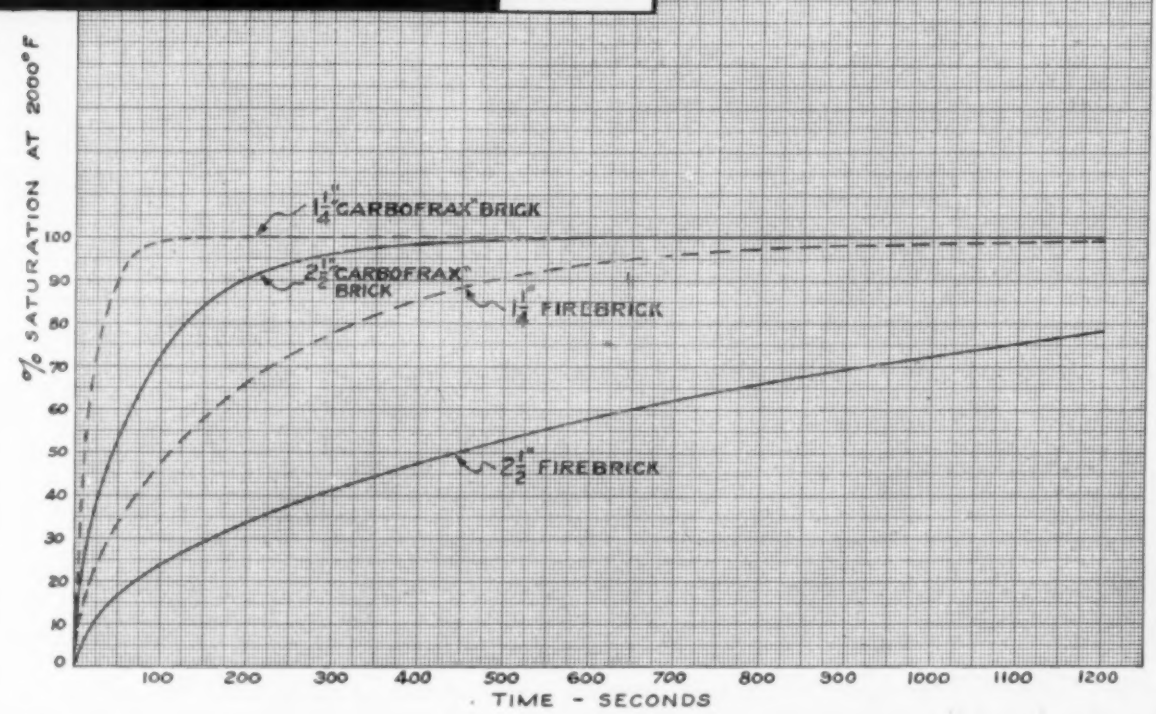
U. S. Production of Synthetic Organic Chemicals (Cont. from page 292)

Chemical	March 1947	March 1946	Total, Three Months 1947	Total, Three Months 1946
Aniline	9,403,327	7,607,352	26,634,575	21,083,396
Barbituric acid derivatives:[1]				
5-Ethyl-5-phenylbarbituric acid and salts (Phenobarbital)	36,575	34,105	101,501	89,372
Benzene:				
Motor grade:				
Tar distillers[4]	695,067	971,183	2,093,667	2,988,864
Coke-oven operators[5]	1,771,195	3,057,504	6,434,841	7,164,833
All other grades:				
Tar distillers[4]	979,279	1,726,978	4,806,850	5,219,068
Coke-oven operators[5]	12,692,241	10,303,242	36,535,435	21,411,043
Butyl alcohol, primary, normal	10,821,123	7,890,619	23,227,556	25,189,594
Carbon bisulphide	30,263,833	25,178,201	86,064,332	75,717,904
Carbon tetrachloride	17,829,018	12,368,263	51,259,341	37,573,224
Chlorobenzene, mono	25,691,394	21,808,709	73,267,948	63,777,458
Creosote oil:				
Tar distillers[4]	11,284,949	10,571,207	33,673,456	28,088,495
Coke-oven operators[5]	3,411,455	2,725,111	9,641,034	5,439,600
Cresols:				
Meta-para	554,430	405,555	1,363,702	978,706
Ortho-meta-para	644,173	705,560	2,033,062	2,014,484
Cresylic acid, refined[7,10]	2,234,164	2,169,272	6,469,957	4,889,981
Dibutyl phthalate	1,720,649	1,428,525	5,715,020	.....
Dichlorodiphenyltrichloroethane (DDT)	4,287,005	3,380,369	12,313,714	10,091,882
Ethyl acetate (85%)	7,902,389	7,750,675	28,171,248	20,582,818
Ethylene glycol	15,115,661	.....	47,340,589	.....
Ethyl ether	3,487,683	3,739,257	11,024,663	9,623,335
Formaldehyde (37% by wt.)	45,402,073	41,822,668	133,409,644	119,287,268
Methanol:				
Natural[3]	1,293,924	1,313,126	3,983,044	3,944,073
Synthetic	46,418,582	46,419,578	139,222,666	136,031,515
Naphthalene:				
Tar distillers, less than 79° C.	25,021,932	15,108,529	60,828,128	41,168,445
Tar distillers, 79° C. and over	8,105,233	8,386,064	34,680,128	24,830,899
Coke-oven operators, less than 79° C.	7,316,406	7,104,529	21,029,389	13,503,561
Penicillin[9]	2,679,318	1,990,734	7,780,285	5,206,722
Phenol, synthetic and natural	21,410,584	16,968,899	55,712,398	46,843,628
Phthalic anhydride	11,689,912	9,776,815	34,223,957	25,932,411
Styrene, government owned plants	16,290,806	20,870,809	50,042,066	63,798,393
Toluene, coke-oven operators	2,409,192	1,782,474	6,452,993	3,992,896
Toluene, all other[9]	2,520,291	1,209,382	8,641,406	3,178,500
Xylene, crude, from coal-tar and petroleum	5,500,384	.....	13,344 268	.....

All data in pounds except benzene (gal.) creosote oil (gal.), toluene (gal.) xylene (gal.) and penicillin (million Oxford units). Statistics collected and compiled by U. S. Tariff Commission except where noted. Absence of data on production indicates either that returns were unavailable or confidential. [1] Excludes the statistics on recovered acid. [2] Acid produced by direct process from wood and from calcium acetate. [3] All acetic anhydride including that from acetic by vapor-phase process. [4] Product of distillers who use purchased coal tar only or from oil-gas or water-gas produced or purchased by tar distillers. [5] Statistics are given in terms of bulk medicinals only. [6] Statistics collected by Bureau of Mines. [7] Total production including data reported both by coke-oven operators and by distillers of purchased coal tar. [8] Reported to U. S. Bureau of the Census. [9] Includes toluene produced from petroleum by any process. [10] Includes refined cresylic acid from petroleum.

GETTING GREATER CAPACITY FROM SMALLER REGENERATORS IN REFORMING ORGANIC GASES

POINT No. 2



CARBOFRAX Checkers provide Faster Saturation

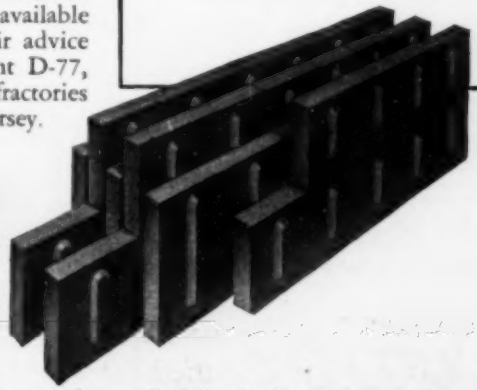
At 2000°F., 100% heat saturation of 1¼" split CARBOFRAX silicon carbide brick is achieved in 150 seconds. Over 1200 seconds are required to attain comparable saturation of fireclay splits under the same conditions. Further proof of the extraordinarily faster heat saturation of CARBOFRAX checkers is furnished by charted data above. They explain why these checkers make it possible to shorten operating cycles—increase available heat storage—reduce checkerwork structures—get greater capacity from smaller regenerators.

With a thermal conductivity 11 to 12 times that of fireclay, CARBOFRAX checkers offer little resistance to heat flow. Absorption is much more rapid. Complete heat saturation is obtained in far less time. This heat is given up just as fast or faster on reversals. Shorter cycles with increased output are assured.

One important consideration in using CARBOFRAX checkers is that the regenerators must be designed to take full advantage of their unique characteristics. In this connection our engineers are available for consultation. To secure their advice and assistance, write Department D-77, The Carborundum Company, Refractories Division, Perth Amboy, New Jersey.

5 ADVANTAGES
Offered by CARBOFRAX Checkers

1. Faster Heat Absorption
2. Faster Saturation
3. Faster Heat Release
4. High Refractoriness
5. Greater Spalling Resistance



SUPER REFRACTORIES
BY CARBORUNDUM
TRADE MARK

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CHEMICAL ENGINEERING

Weighted Index of Prices for CHEMICALS

Base = 100 for 1937

This month	**124.09**
Last month	124.02
July, 1946	110.50
July, 1945	108.70

CURRENT PRICES

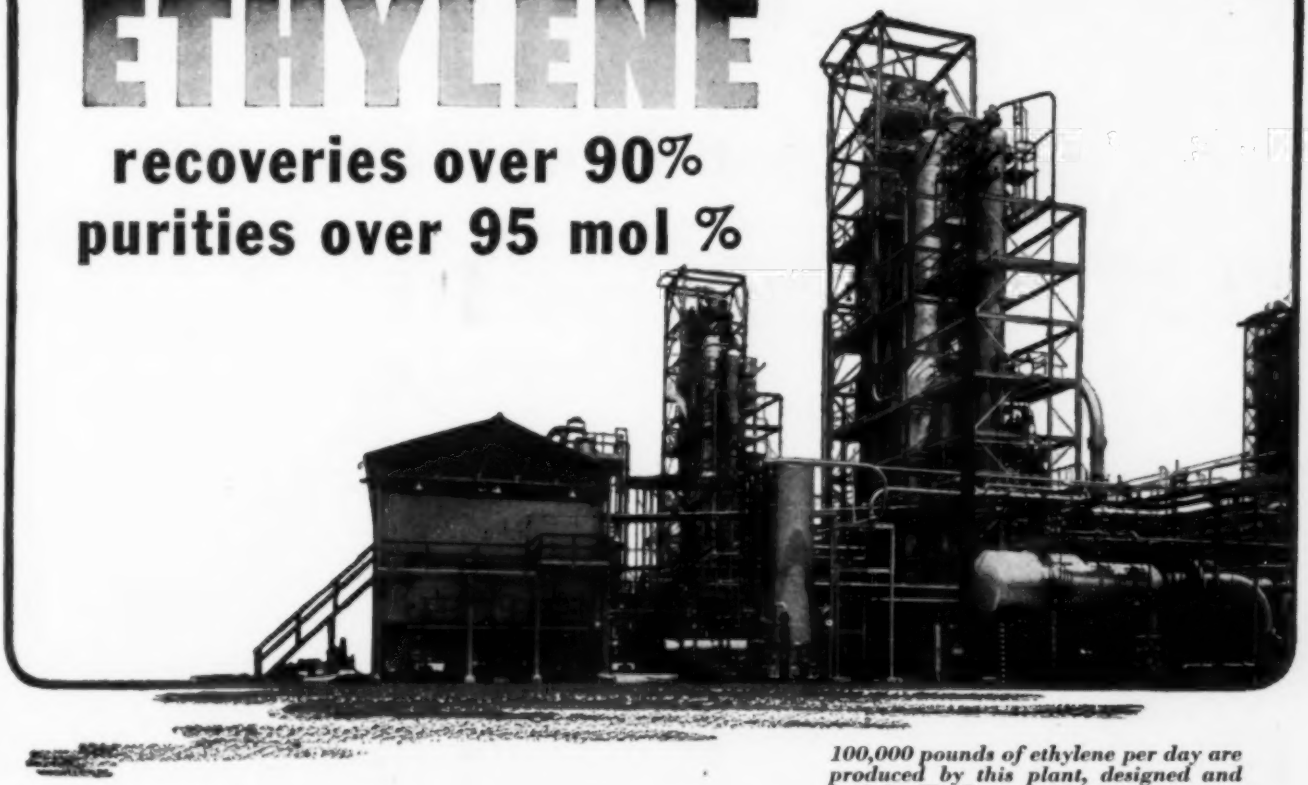
The accompanying prices refer to round lots. Where it is trade custom to sell f.o.b. works, quotations are so designated. Prices are corrected to July 7.

INDUSTRIAL CHEMICALS

Acetone, tank, lb.	$0.07 - $0.09
Acid, acetic, 28%, bbl., 100 lb.	3.78 - 4.03
Boric, bbl., ton	119.00 -123.00
Citric, drums, lb.	.24½- .26
Formic, cbys., lb.	.12 - .12½
Hydrofluoric, 30%, drums, lb.	.08 - .085
Lactic, 44% tech., light, bbl., lb.	.0815- .0855
Muriatic 18°, tanks, 100 lb.	1.00 -
Nitric, 36°, carboys, lb.	.05 - .05½
Oleum, tanks, wks., ton	19.50 - 20.00
Oxalic, crystals, bbl., lb.	.13 - .14
Phosphoric tech., tanks, lb.	.0465-
Sulphuric, 60°, tanks, ton	13.00 -
Tartaric, powd., bbl., lb.	.49½- .50
Alcohol, amyl from pentane, tanks, lb.	.151-
Alcohol, butyl, tanks, lb.	.14½- .29
Alcohol, ethyl, denatured, No. 1 special tanks, gal.	.98 -
Alum, ammonia, lump, lb.	.04½-
Aluminum sulphate, com. bags, 100 lb.	1.15 - 1.25
Ammonia, anhydrous, cyl., lb.	.16 - .20
tanks, ton	59.00 - 61.50
Ammonium carbonate, powd., casks, lb.	.09½- .10
Sulphate, wks, ton	30.00 - 33.00
Amyl acetate, tech. from pentane, tanks, lb.	.21 -
Aqua ammonia, 26°, drums, lb.	.03 - .03½
tanks, ton	65.00 -
Arsenic, white powd., bbl. lb.	.06 - .07
Barium carbonate, bbl., ton	67.50 - 75.00
Chloride, bags, ton	85.00 - 90.00
Nitrate, casks, lb.	.11½ .12
Blanc fixe, dry, bags, ton	67.50 - 72.50
Bleaching powder, f.o.b. wks., drums, 100 lb.	2.75 - 3.00
Borax, gran., bags, ton	48.50 -
Calcium acetate, bags, 100 lb.	3.00 -
Arsenate, dr., lb.	.09½- .10
Carbide, drums, ton	50.00 -
Chloride, flake, bags, del., ton	21.50 - 38.00
Carbon bisulphide, drums, lb.	.05 - .05½
Tetrachloride, drums, lb.	.06½- .07
Chlorine, liquid, tanks, wks., 100 lb.	2.00 - 2.30
Copperas, bgs., f.o.b., wks., ton	17.00 - 18.00
Copper carbonate bbl., lb.	.24 - .27
Sulphate, bags, 100 lb.	7.60 - 7.75
Cream of tartar, bbl., lb.	.41½- .42
Diethylene glycol, dr., lb.	.14 - .15
Epsom salt, dom., tech., bbl., 100 lb.	2.05 - 2.25
Ethyl acetate, tanks, lb.	.09½ .19
Formaldehyde, 30%, dr., wks., lb.	.0545-
Furfural, tanks, lb.	.09½-
Glaubers salt, bag , 100 lb.	1.25 - 1.50
Glycerine, c. p., drums, extra, lb.	.30 - .35
Lead: white, basic carbonate, dry casks, lb.	.15½-
Red, dry, sck., lb.	.18 -
Lead acetate, white crys., bbl., lb.	.19½- .20½
Arsenate, powd., bags, lb.	.21½- .22
Lithopone, bags, lb.	.05½- .06
Magnesium carb., tech., bags, lb.	.07½- .08
Methanol, 95%, tanks, gal.	.60 -
Synthetic, tanks, gal.	.24 - .29
Phosphorus, yellow, cases, lb.	.22 - .25
Potassium bichromate, bags, lb.	.10½- .10½
Chlorate, powd., lb.	.09 - .09½
Hydroxide (c'stic potash) dr., lb.	.07½- .09½
Muriate, 60%, bags, unit	.37½-
Nitrate, ref., bbl., lb.	.08½- .21
Permanganate, drums, lb.	.20½- .21½
Prussiate, yellow, casks, lb.	.19 - .20
Sal ammoniac, white, casks, 100 lb.	4.75 - 5.00
Salsoda, bbl., 100 lb.	1.10 - 1.20
Salt cake, bulk, ton	20.00 -
Soda, ash, light, 58%, contract, bags, 100 lb.	1.20 -
Dense, bags, 100 lb.	1.28 -
Soda, caustic, 76% solid, drums, 100 lb.	2.50 -
Acetate, del., lb.	.05½- .06
Bicarbonate, bags, 100 lb.	2.25 -
Bichromate, bags, lb.	.08½- .08½
Bisulphate, bulk, ton	20.00 - 24.00
Bisulphite, bbl., lb.	.03 - .04

ETHYLENE

recoveries over 90%
purities over 95 mol %



100,000 pounds of ethylene per day are produced by this plant, designed and built by The Lummus Company.

. . . without low-temperature refrigeration

In 1943 Lummus completed construction of an ethylene plant for one of the nation's best known chemical companies. With this plant (the first to employ the absorption process for the purification of ethylene) the company has consistently obtained high ethylene recoveries (over 90%) and purities (up to 95 mol %) without use of extreme low-temperature refrigeration.

Among other basic advantages which Lummus incorporated in this plant are flexibility, economical resolution of the charge and furnace effluent gas streams, and ease of control.

Lummus is currently completing construction of two similar ethylene plants with even higher purity—99+mol % ethylene.

With complete research and construction facilities—and with broad experience in petroleum refining and chemical production—Lummus is well prepared to design and build your facilities for the production of ethylene, propylene, phenol, and other chemicals from petroleum.

THE LUMMUS COMPANY
420 Lexington Avenue, New York 17, N. Y.

LUMMUS
chemical processes and plants

CHICAGO—600 South Michigan Avenue, Chicago 5, Ill.
HOUSTON—Mellie Esperson Bldg., Houston 2, Texas
LONDON—78 Mount Street, London, W. 1, England

CHEMICAL ENGINEERING
Weighted Index of Prices for
OILS & FATS

Base = 100 for 1937

This month	**220.34**
Last month	237.60
July, 1946	153.39
July, 1945	145.85

Chlorate, kegs, lb.	$0.06½ -	$0.06¾
Cyanide, cases, dom., lb.	.14½ -	.15
Fluoride, bbl., lb.	.09½ -	.09¾
Hyposulphite, bags, 100 lb.	2.25 -	2.50
Metasilicate, bbl., 100 lb.	3.40 -	4.00
Nitrate, bulk, ton	32.00 -	38.50
Nitrite, casks, lb.	.06½ -	.07
Phosphate, tribasic, bags, 100 lb.	3.50 -	.....
Prussiate, yel., bags, lb.	.12 -	.12½
Silicate, 40°, dr., wks., 100 lb.	.95 -	1.00
Sulphite, crys., bbl., lb.	.02½ -	.02¾
Sulphur, crude at mine, long ton	16.00 -	18.00
Dioxide, cyl., lb.	.085-	.09
Dioxide, tanks, lb.	.044-	.....
Tin crystals, bbl., lb.	.55 -	.....
Zinc chloride, gran., bbl., lb.	.07 -	.07½
Oxide, lead free, bags, lb.	.09½ -	.09¾
Oxide, 35%, leaded, bags, lb.	.11½ -	.11¾
Sulphate, bags, cwt.	4.15 -	7.00

OILS AND FATS

Castor oil, No. 3 dr., lb.	$0.26 -	.....
Chinawood, oil, tanks, lb.	.23 -	.....
Coconut oil, Ceylon, N. Y., lb.	.12 -	.....
Corn oil, crude, tanks, (f.o.b. mill), lb.	.21 -	.....
Cottonseed oil, crude (f.o.b. mill), tanks, lb.	.21½ -	.....
Linseed oil, raw, car lots, dr., lb.	.304-	.....
Palm, casks, lb.	nom.	
Peanut oil, crude, tanks (mill), lb.	.22 -	.....
Rapeseed oil, refined, bbl., lb.	nom.	
Soybean, tanks, lb.	.17 -	.....
Menhaden, light, pressed dr., lb.	.23 -	.....
Crude, tanks (f.o.b. factory), lb.	nom.	
Grease, yellow, loose, lb.	.10½ -	.....
Oleo stearine, lb.	nom.	
Oleo oil, No. 1, lb.	.19 -	.....
Red oil, distilled, bbl., lb.	.18½ -	.....
Tallow, extra, loose, lb.	.10½ -	.....

COAL TAR PRODUCTS

Alpha-naphthol, crude, bbl., lb.	$0.58 -	$0.60
Alpha-naphthylamine, bbl., lb.	.35 -	.36
Aniline oil, drums, lb.	.13 -	.13¼
Aniline salts, bbl., lb.	.22 -	.24
Benzaldehyde, tech., dr., lb.	.45 -	.50
Benzidine base, bbl., lb.	.75 -	.77
Benzoic acid, USP, kegs, lb.	.54 -	.56
Benzol, 90%, tanks, works, gal.	.19 -	.....
Benzyl chloride, tech., dr., lb.	.20 -	.21
Beta-naphthol, tech., drums, lb.	.23 -	.24
Cresol, USP, dr., lb.	.13½ -	.....
Cresylic acid, dr., wks., gal.	1.00 -	1.05
Diphenyl, bbl., lb.	.16 -	.....
Diethylaniline, dr., lb.	.48 -	.50
Dinitrotoluol, bbl., lb.	.18 -	.19
Dinitrophenyl, bbl., lb.	.22 -	.23
Dip oil, 15%, dr., gal.	.23 -	.25
Diphenylamine, dr., f.o.b. wks., lb.	.25 -	.....
H acid, bbl., lb.	.50 -	.52
Hydroquinone, bbl., lb.	.90 -	.95
Naphthalene, flake, bbl., lb.	.10½ -	.11
Nitrobenzene, dr., lb.	.08½ -	.09
Para-cresol, bbl., lb.	.41 -	.....
Para-nitroaniline, bbl., lb.	.42 -	.43
Phenol, USP, tanks, lb.	.10½ -	.11
Picric, acid, bbl., lb.	.30 -	.32
Pyridine, dr., gal.	1.55 -	1.60
Resorcinol, tech., kegs, lb.	.68 -	.70
Salicylic acid, tech., bbl., lb.	.26 -	.27
Solvent naphtha, w. w., tanks, gal.	.25 -	.....
Toluidin, bbl. lb.	1.00 -	.....
Toluol, drums, works, gal.	.23 -	.....
Xylol, com., tanks, gal.	.25 -	.....

MISCELLANEOUS

Casein, tech., bbl., lb.	$.24 -	$.30
Dry colors:		
Carbon gas, black (wks.), lb.	.04 -	.07
Prussian blue, bbl., lb.	.42 -	.43
Ultramarine blue, bbl., lb.	.13 -	.24
Chrome green, bbl., lb.	.31 -	.40
Carmine red, tins, lb.	5.50 -	6.00
Para toner, lb.	.80 -	.95
Vermilion, English, bbl., lb.	2.50 -	2.70
Chrome yellow, C. P., bbl., lb.	.26 -	.28
Gum copal, Congo bags, lb.	.09 -	.55
Manila, bags, lb.	.09 -	.15
Damar, Batavia, cases, lb.	.10 -	.22
Kauri, cases, lb.	.18	.60
Magnesite, calc., ton	60.00 -	.....
Pumice stone, lump, bbl., lb.	.05 -	.07
Rosin, H., 100 lb.	8.00 -	.....
Shellac, orange, fine, bags, lb.	.55 -	.57
Bleached, bonedry, bags, lb.	.58 -	.60
T. N. bags, lb.	.54 -	.55
Turpentine, gal.	.75 -	.....

NEW CONSTRUCTION

Calif., San Francisco—Glidden Co., 1300 7th St., San Francisco, Calif., plans to construct a paint factory. Estimated cost $200,000.

Del., Newark—E. I. du Pont de Nemours & Co., Inc., Wilmington, Del., plans to construct a sales research and display laboratory addition. Estimated cost $500,000.

Fla., Arcadia—South Pine Extracting Co., Arcadia, plans to construct a plant for extracting and processing pine tar and pine oils. Estimated cost $65,000.

Fla., Jacksonville—Allied Chemical & Dye Corp., c/o Industrial Division of Chamber of Commerce, Jacksonville, plans to construct a modern alumna sulphate plant for the production of heavy industrial chemicals. Plant will be known as General Chemical Co. D. C. Hollander, c/o owner, Engr. Estimated cost between $65,000 and $75,000.

Ga., Macon—General Chemical Co., Hurt Bldg., Atlanta, plans to construct a manufacturing plant. Estimated cost $200,000.

Ky., Louisville—B. F. Goodrich Co., Bell's Lane, plans to construct a resin and plastics plant. Estimated cost $190,000.

Mass., Peabody—Eastman Gelatine Corp., Peabody, plans to construct a photo gelatine plant. Estimated cost $66,473.

Minn., Winona—Armour & Co., U. S. Yards, Chicago, Ill., plans to construct a fertilizer plant here. Estimated cost $400,000.

N. J., Elizabeth—Beacon Supply Co., 103 Fifth St., plans to construct a plant for the manufacture of plastic novelties. Estimated cost $140,000.

Pa., Philadelphia—Atlantic Refining Co., 260 South Broad St., plans to construct an addition to its Point Breeze Refinery. Estimated cost $88,100.

Tex., Corpus Christi—Pontiac Refining Corp., 3400 Lawrence Dr., plans to construct a refinery. Estimated cost will exceed $1,000,000.

Tex., Corpus Christi—Southwestern Oil & Refining Co., Port and Sommers Sts., plans to construct a new refinery. Estimated cost $3,750,000.

Tex., Hebbronville—Sun Oil Co., M. Esperson Bldg., Houston, plans to construct a new pressure maintenance plant. Estimated cost $160,000.

Tex., Houston—Sinclair Refining Co., Gulf Bldg., plans to expand its refinery located between Houston and Pasadena. Estimated cost $25,000,000.

Tex., Ricardo—Magnolia Pipe Line Co., Beaumont; Sunray Oil Corp., Sun Oil Co., Shell Bldg., Houston and Sinclair Prairie Oil Co., Houston, plans to construct a natural gasoline plant and a recycling plant at Ricardo near Kingsville. Estimated cost $6,000,000 and $4,000,000 respectively.

Tex., Roma—Sun Oil Co., M. Esperson Bldg., Houston, plans to construct a new pressure maintenance plant here. Estimated cost $175,000.

	Current Projects		Cumulative 1947	
	Proposed Work	Contracts	Proposed Work	Contracts
New England	$66,000	.....	$8,961,000	$2,279,000
Middle Atlantic	728,000	$1,761,000	6,842,000	15,346,000
South	595,000	388,000	11,361,000	10,071,000
Middle West	400,000	1,240,000	16,448,000	12,440,000
West of Mississippi	40,335,000	985,000	231,412,000	75,377,000
Far West	200,000	65,000	4,206,000	11,756,000
Canada	.....	490,000	51,846,000	13,600,000
Total	$42,324,000	$4,929,000	$331,076,000	$140,869,000

Tex., Sweeney—Alamo Refinery Co. & Associates, Sweeny, plans to improve its refinery here. Estimated cost $250,000.

Contracts Awarded

Calif., Redwood City—Chemical Process Co., 58 Sutter St., San Francisco, has awarded the contract for the second unit of its factory building here to Wagner & Martinez, 181 South Park, San Francisco. Estimated cost $65,000.

Del., Wilmington—Atlas Powder Co., Delaware Trust Bldg., has awarded the contract for an industrial chemical plant to Foley Bros., Inc., Pleasantville, N. Y. Estimated cost $1,600,000.

Fla., Jacksonville—Atlantic Refinery Co., Lynch Bldg., has awarded the contract for storage building, enlarging terminal docks, etc., to Chicago Bridge & Iron Co., 1500 North 50th St., Birmingham, Ala. Estimated cost $325,000.

Ind., Indianapolis—Pitman-Moore Co., manufacturer of pharmaceuticals, 1200 Madison Ave., has awarded the contract for 6 story plant, including additional laboratory and receiving building, to Carl M. Geupel Construction Co., 1109 Hume Mansur Bldg. Estimated cost $1,000,000.

Mich., Saginaw—Farm Bureau Service, Inc., Lansing, Mich., has awarded the contract for a fertilizer plant in Buena Vista Township, to Granger Bros. Construction Co., Lansing. Estimated cost $98,000.

Minn., Red Wing—Pittsburgh Plate Glass Co., 616 South Third St., Minneapolis, has awarded the contract for a 1 story addition to its plant here to Fruin-Colnon Contracting Co., 1700 Olive St., St. Louis, Mo. Estimated cost including equipment $55,000.

Mo., St. Louis—Monsanto Chemical Co., 1700 South Second St., has awarded the contract for alterations and improvements to its 2 story factory building to Fruin-Colnon Contracting Co., 1700 Olive St. Estimated cost including equipment $55,000.

O., Richfield—East Ohio Gas Co., East 6th and Rockwell Sts., Cleveland, has awarded the contract for three additions to its plant here to Carmichael Construction Co., 148 East Nilter St., Akron. Estimated cost $87,000.

Pa., Emlenton—Quaker State Oil Refining Corp., Emlenton, has awarded the contract for a filter building and compressor building to H. T. Osborne Co., 12th St., Franklin. Estimated cost including equipment $105,000.

Pa., Pittsburgh—American Cyanamid & Chemical Corp., 30 Rockefeller Plaza, New York, N. Y., has awarded the contract for a control building to Martin & Nettcour, 605 Pitt Bank Bldg. Estimated cost $56,000.

Tex., Dallas—Magnolia Petroleum Co., Magnolia Bldg., has awarded the contract for a warehouse to J. W. Bateson Construction Co., Irwin-Keasler Bldg. Estimated cost $70,000.

Tex., Orange—Orange Building Corp., Orange, will construct a chemical plant by day labor. Estimated cost $90,000.

Wash., Seattle—Monsanto Chemical Co., 1700 South Second St., St. Louis, Mo., has awarded the contract for a factory and warehouse here to Howard S. Wright Co., 407 Yale Ave., N. Estimated cost $715,000.

W. Va., Bridgeport—Hope Natural Gas Co., Clarksburg, W. Va., will construct a 1 story, 38x65 ft. addition to its compressor building. Work will be done by separate contracts. Estimated cost $63,000.

Wis., Green Bay—Forkin Phosphate Co., De Pere, has awarded the contract for a 1 story, 96x190 ft. acid plant here to J. C. Basten, 1329 Main St.

Alberta—Alberta Gas Services, Ltd., Edmonton, will construct liquified gas bulk storage plants at Cardston and Ponoka. Work will be done by owners. Estimated cost $60,000 each.

N. B., Hartland—New Brunswick Potato Products, Ltd., has awarded the contract for a starch factory to Donald Nicholson, Hartland. Estimated cost $55,000.

Ont., Toronto—Canadian Oil Co., Ltd., Terminal Warehouse Bldg., has awarded the contract for gasoline storage tanks to A. E. Rule, Ltd., 1109 Millwood Rd., Leaside. Estimated cost $65,000.

Ont., Toronto—McColl-Frontenac Oil Co., Ltd., Yardley Bldg., Toronto, has awarded the contract for a 1 story tank house to Foundation Co. of Ontario, Ltd., 1220 Bay St., Toronto. Estimated cost $60,000.

Ont., Weston—Canadian Kodak Co., Ltd., Eglinton Ave., has awarded the contract for a factory and office building to Bradford-Hoshal Ltd., 1170 Yonge St., Toronto. Estimated cost $250,000.